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THE EDUCATION SYSTEM IN GREAT BRITAIN

AN impartial observer is unlikely to claim that the Government has as yet distinguished itself in the field of education, though perhaps the recent introduction of the Minister of Education into the Cabinet heralds a change. For the past, hopes entertained in the field of higher technological education have not materialized, though both major political parties are committed to the establishment of, at any rate, one major technological institution of university rank. Of a policy for technical education there has been no sign, and a speech of the Prime Minister's, if not his personal intervention, redeemed a situation in which alarm over the future of adult education had been caused. A recent report on the schools by the Select Committee on Estimates has been used for attacking the Government ; but the shortcomings revealed by that report are the responsibility of successive governments and must be shared equally by both parties. The real burden of that report is one equally implied by the subsequent report of the University Grants Committee, and is a challenge to realistic thinking which both political parties must heed.

The report in question, the eighth from the Select Committee on Estimates for the Session 1952–53*, is based on the Committee's examination of the expenditure on schools proposed in the estimates for public education in England, Wales and Scotland for 1953–54 in the light of the intention of the Education Acts of 1944 and 1946. At every point the Committee was confronted with overcrowding, lack of schools, heavy transport costs, a shortage of teachers and often rapidly deteriorating and even dangerous school buildings. It points out that the high birth-rate between 1944 and 1948 has swollen the population in primary schools beyond what may be regarded as an average annual expectation. This increased number of scholars will soon be entering secondary schools which, with their requirement for smaller classes, will experience even greater difficulties than the primary schools have done. It is unlikely to affect university entry until about 1960. Besides this, the general shortage of materials and labour has proved far worse over a longer period than was foreseen in 1945, and the impact of the defence programme has been another adverse factor.

In a reply to the Committee's criticisms, published on July 17, the Ministry of Education does not agree that competing demands upon materials and labour made by the housing programme are a main cause of any difficulty in the school building programme keeping pace with the housing programme, or even that the cuts in capital expenditure made in 1951 and the subsequent three months moratorium had an adverse effect on the school building programme. The Ministry also refuses to accept the Select Committee's conclusion that insufficient care was taken in estimating the number of school places which must

* Eighth Report from the Select Committee on Estimates, together with the Minutes of Evidence taken before Sub-Committee E and Appendices. Session 1952–1953. Schools. Pp. xxii+233. (London : H.M. Stationery Office, 1953.) 9s. net.

be provided, and affirms that it is the Ministry's policy to build new schools to reduce the size of classes, or to eliminate the need for makeshift accommodation. The policy of the present Ministry, and of its Labour predecessor, it is stated, has been based on the fact that building resources were not adequate both to meet these needs and to provide school places for the growing number of children and for the children moving to new areas.

The reply does not deny that the condition into which many of the older schools in Great Britain have fallen is the worst feature of all educational buildings, or that the Ministry has assumed that the buildings available at the end of the War must be deemed to be acceptable for the next decade or more. The Ministry's reply to the criticisms of the Select Committee is clever rather than convincing. It is concerned rather to defend and to save the face of the Ministry and in doing so, quite independently and irrespective of the political nature of successive Governments responsible for the same policy, only emphasizes the gravamen of the main charge of the Select Committee and which it studiously avoids.

That charge, not indeed explicitly formulated, is that in respect of the educational programme to which both political parties have committed themselves under the Acts of 1944 and 1946, the resources allotted to education have been quite inadequate. The Ministry of Education has been attempting to carry out an impossible task. Either it must be given the resources that it requires for the task or the educational aims and programme should be adjusted in accordance with whatever allocation of resources can be made in consideration of other national needs.

If the facts disclosed by the Select Committee's report make nonsense of the Ministry of Education's disclaimer for estimating requirements and rebuke both Governments alike responsible for educational policy since the War for lack of realism, they no less make nonsense of the large proposals for the reform of secondary education advanced in the Labour Party's statement, "Challenge to Britain". Whatever the merits of the abolition of 'the eleven-plus' examination, the proposal to replace existing grammar schools and public schools by a system of new comprehensive secondary schools involves an even larger building programme at a time when the increase in the school population is likely to make it even more difficult to secure the smaller classes, if not the larger number of teachers, upon which success will largely depend. There may well be much to be said for the proposals for comprehensive secondary schools, but their merits are as yet unproved. The Estimates Committee's report shows clearly that the prospect of achieving the conditions essential for the success of any such drastic change are for the present remote on purely practical grounds.

This argument is supported by an analysis of the cost of social services during 1938–52 made by Political and Economic Planning in a recent broadsheet (No. 354, June 15, 1953). Whereas in 1938–39 expenditure on education amounted to £111·8 millions out of a total expenditure on social services of the United Kingdom of £527·4 millions, in 1951–52 it was £328·2 millions out of £2,011 millions. As a percentage of the national income it had only increased from 2·0 to 2·2 and now stood fourth to the social security services (including social insurance, assistance, war pensions, family allowances and poor relief), the second place (3·3 per cent compared with 1·3 per cent in 1938–39) having been taken by health, hospital and domiciliary services, while food subsidies accounted for 2·3 per cent. Expenditure on education per child under fifteen had risen from £10 17*s.* to £28 13*s.*, while between 1938 and 1951 the number of children in the 5–14 age-groups attending grant-aided schools rose by about 10 per cent.

That is, of course, not to deny the practicability or indeed the desirability of limited and careful experiment in this direction, so that when it is possible to allocate increased and adequate resources to the school building programme there may be available some practical evidence of their value and potentialities as against the proved value of the grammar schools and the public school system. A decision might then be possible not on the grounds of political or social theory but on more substantial grounds of educational experience. New needs, as Rashdall reminded us in his great work on the universities, must be met by new machinery, and universities are not the only educational institutions which must undergo perpetual modification in the future as they have undergone it in the past. Here also it is wise, as in wider fields of social, political and religious organization, so far as possible to preserve historical continuity, and to remember Zinsser's affirmation that no democracy can maintain itself for any length of time without building up an aristocracy of ability and talent to protect it from deterioration and eventual chaos.

It would be unfortunate, indeed, if the Ministry of Education's concern to save its own face led it to neglect to implement the several very sensible recommendations of the Select Committee for improving the situation. They are minor rather than fundamental, though they should encourage a more realistic attitude and some attempt to bring educational aims and policy more into line with the resources which the Government is prepared to allocate. More fundamental and critical thought, however, is demanded as well as more sincerity, and it is as a contribution to such thought that a further book on education by Dr. J. B. Conant is to be welcomed*.

Dr. Conant believes with Mill that the worth of a State, in the long run, is the worth of the individuals composing it and that a State which dwarfs its men, in order that they may be more docile instruments in its hands even for beneficial purposes, will find that with small men no really great thing can be accomplished. For him the issue between liberty and totalitarianism depends on whether democracy, as the term is commonly understood in the Western world, can throw up not merely an *élite* but ordinary citizens capable of meeting the intellectual and moral demands which the functioning of a democratic

* Education and Liberty: the Role of the Schools in a Modern Democracy. By James Bryant Conant. Pp. xv+168. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1953.) 20*s.* net.

system makes. The answer to this in turn depends largely on the nature of the educational system. Dr. Conant's book is essentially a tract for the times in which the axiom that "liberty can never be safe but in the hands of the people themselves, and that, too, of the people with a certain degree of instruction" is examined in the context of what degree of instruction it implies should be provided in the context of to-day.

But Dr. Conant's examination is more limited than his title or sub-title implies. The Jeffersonian axiom just quoted is taken as text for three lectures given at the University of Virginia which were not merely addressed to an American audience but were concerned with the role of the schools in a particular democracy—the United States. In the first, under the title the Anglo-Saxon tradition, a comparison is given of the present status of secondary education in the United Kingdom, Australia, New Zealand and the United States. This is followed by an account of the American institution, the liberal arts college with its four-years course, and of its influence on secondary education in the United States. This includes some account for the American citizen of the British university system and its relation to the schools, while the third lecture, or chapter, outlines the problems in this field which immediately confront the United States, and details Dr. Conant's own proposals to meet a situation in which a fifty per cent increase in the number of adolescents is expected in 1960.

Dr. Conant's book is accordingly of less general interest than might at first appear. Because he could assume on the part of his American audience or reader a knowledge of conditions in the United States which will not normally be shared by a British reader, for the latter his exposition will not have quite the same sharpness of meaning as for an American reader. In this book he is likely to be more successful in explaining the British system and practice to an American reader than the United States system to a British reader. Moreover, Dr. Conant regards education as a social process, related in each century to the current political scene, to social history and national ideals. The social behaviour characteristic of a people is more significant in determining the nature of the schools than the acceptance of any particular philosophy of education. Nor does Dr. Conant believe that educational practices are an exportable commodity.

Here can be seen the real value of Dr. Conant's book for those outside the United States. Firmly rejecting the doctrinaire approach which has marred much current discussion, he insists that if the educational experience in one country is to be any help to another, a determined effort must be made to think out the situation objectively and to take account of contrasting social outlook and experience before attempting to apply either system or practice. It is a challenge to thought which is the more topical and stimulating in view of the controversy over the comprehensive high school in Great Britain, and the proposals already mooted for jettisoning both the public school and the grammar school in favour of the unproved and still hypothetical advantage of the comprehensive school.

Dr. Conant himself is a convinced believer in the comprehensive high school for America, partly because he believes it favours social coherence and partly because he approves of vocational specialization starting late. But he is concerned that such a system does accept lower standards for the sake of a more widely diffused education, and still more is he concerned at its failure to provide adequate opportunity for the gifted. He recognizes the need for more attention to this question of the aristocracy of talent and for assuring diversity in education, and his warning that educational *practices* are not exportable only emphasizes the value of the interchange of thought.

Dr. Conant's book is not profound; but although its straightforward account of different educational systems is clearer to an American than to an English reader, the latter will find the book both topical and suggestive. It gives clear warning of the dangers of a doctrinaire approach to educational problems and especially of allowing such an approach to determine practice without regard to the whole social and educational context. Dr. Conant, moreover, does not believe in abandoning or disturbing established educational systems except for very clearly demonstrated reasons. For all his advocacy of the American high school, he would be the first to warn us that before attempting to import such a system or practice, we should be quite clear first as to what fresh contribution to education that system had made in the United States and what values it had brought to politics, to culture, entertainment or social life that would justify abandonment of our own system. Even if such a change were justified, Dr. Conant, who believes also in experiment and in change, would remind us that what Bacon wrote of innovations was never more true than of innovation in education: "It were good, therefore, that men in their Innovations would follow the example of Time itself, which indeed innovateth greatly, but quietly, and by degrees scarce to be perceived".

THE WORKERS' EDUCATIONAL ASSOCIATION

The Workers' Educational Association
The First Fifty Years. By Mary Stocks. Pp. 157. (London: George Allen and Unwin, Ltd., 1953.) 12*s.* 6*d.* net.

THE history of any organization which is celebrating a special occasion is often no more than a dull catalogue of events which has little interest except for those few people who were in some way connected with those events. One might be forgiven, therefore, if one confessed that, after reading Mary Stocks's apologetic preface to this book, one anticipated a wearisome chronicle which had to be read out of a sense of loyalty to the unique efforts of the Workers' Educational Association in adult education.

Never were fears so groundless. Mrs. Stocks has written a remarkably moving story which is full of fascination. The history of the Workers' Educational

Association is so skilfully woven with the social history of the past fifty years that it would have done no discredit to its publishers if the book had also been advertised as a history of the working-class movement in the past half-century.

The key to the book lies in the first chapter. In 1903 the Workers' Educational Association was born; otherwise the year had little to commend it. But Mary Stocks examines the stirrings and movements of the time and prepares the canvas on which she later paints her magnificent portrait of the Workers' Educational Association. In later chapters, her sense of history enables her to relate the growth of this unique adult education movement to the personal, social and economic forces which moulded it. This fine feel for the event of the moment is never better seen than in her account of Mansbridge's almost fatal illness or of the activities of the Workers' Educational Association after the outbreak of the First World War.

In her account of the development of the Workers' Educational Association, one would scarcely expect the author to pay attention to the future growth of the movement. Yet that is a question which perturbs many educationists, and, in the last few pages, Mrs. Stocks examines the problems which confront the Association to-day. Many educationists, she knows, believe that the Workers' Educational Association has completed the task for which it came into being and should voluntarily liquidate itself before it dies of unbecoming decay; there is a widely held belief that adult education can now be most faithfully served by government, the universities and local education authorities. Other educationists believe that there is still much for the Workers' Educational Association to do but that those in control of the movement have lost the inspiration and spirit of service which created and nourished it in its growing years; others believe that those in control are too full of tradition to adapt themselves to new ways demanded by new times. These are the kind of questions which Mrs. Stocks poses. The answers she leaves to others—and the future. Here one feels that Mrs. Stocks has been a little too peremptory with her readers, who would have welcomed her practical and precise advice on the future of the Workers' Educational Association in the light of her researches into its past and her justifiable belief that the Workers' Educational Association will be a powerful force in adult education for many years to come.

If one lesson emerges from this book, it is that the Workers' Educational Association has always been at its best when it had a cause to serve outside its own immediate adult education interests. Mrs. Stocks gives no clear guide as to which road the organization should now follow. Are we to assume that there are no educational causes to serve to-day? Or is it that educational reforms are easy to bring about during and after great wars and that there have been no major educational developments in Great Britain in times of peace? If the Workers' Educational Association wants a cause, why should it not lead the campaign to bring about the real establishment of county colleges which have been on the Statute Book in some form or other for more than thirty years? As Mrs. Stocks implies, such a cause would not lack a friend in the Chancellor of the Exchequer.

And what of the Workers' Educational Association itself? Should it be content with Tawney's advice that it must not be led into "providing education for those who can be most easily induced to undertake it" instead of "for those who need it most". There are many who believe that Tawney has failed to take account of the social movements of the past fifty years and that his advice lacks a sense of realism in 1953. Where are the great tutors of to-day? In many cases devoting their time and energy to committees and voluntary organizations which older members of the Workers' Educational Association have themselves helped to bring into being. Where are the intelligent young students of the working classes? In most cases attending degree courses at universities which were themselves created partly as a result of the efforts of older members of the Workers' Educational Association. Had the working classes of the early part of the twentieth century the radio, television, cinemas and other forms of entertainment, would they have been so assiduous in their attendance at adult education classes? If the standard of living of the working classes in 1903 had been anything like that of 1953, would Tawney's classes on economics have commanded the attention they did?

There are many who believe that noticeable developments in adult education among working classes to-day will only come through an approach which takes into account the changed nature of the people and their changed needs since 1903. The imaginative and courageous approach of the director of extra-mural studies at the University of Sheffield in providing 'day release classes' for working miners at Chesterfield has much to commend it and offers a challenge to the Workers' Educational Association. The work being done by various trade unions in providing residential courses for its members should also be of considerable significance to those in the Workers' Educational Association movement. Factory, commercial and agricultural workers are really concerned with the method of functioning of industry, commerce and agriculture and need enlightenment which perhaps might come from the Workers' Educational Association.

These are the kind of topics on which readers of Mrs. Stocks's book would have welcomed her views. In the meantime, they will be grateful for a magnificent history which does the cause of which she is so rightfully proud no mean service.

T. H. Hawkins

FINANCE OF AMERICAN HIGHER EDUCATION

Financing Higher Education in the United States
By John D. Millett. (The Staff Report of the Commission on Financing Higher Education.) Pp. xix+503. (New York: Columbia University Press; London: Oxford University Press, 1952.) 32*s.* 6*d.* net.

THIS substantial and important book brings to an end a remarkable enterprise. For more than five years, two successive commissions of distinguished American academics have been engaged on an internal audit of higher education in the United States. They have been aided by some equally distinguished men of affairs, by the short-term services of special groups charged to investigate particular issues and continuously by a powerful staff. The inquiry seeks primarily to elucidate the effect of

post-war conditions upon the economic position and prospects of the several categories of American higher educational institutions and to suggest the lines of financial policies which might properly be pursued. But that inquiry calls for a consideration and appraisal of the objectives and programmes of higher education; and much of the best—and to British readers the most instructive—of the commission's work has gone to that end.

The main commission recently published its general findings in a quite short report of two hundred pages on the "Nature and Needs of High Education". But on the way to this definitive document, the commission has issued three preliminary papers and nine volumes of preparatory studies—among them the now famous review of the 'unexportable' British practice in the provision of government assistance to the universities. The present book is the tenth and final volume of the preparatory work. It is the report presented by the staff, in the form given to it by Dr. J. D. Millett, professor of public administration in Columbia University, the whole-time executive director of the inquiry, who clearly has greatly influenced its outcome.

It follows fairly closely the structure of the commission's report. It begins by defining the main categories of higher educational services, and the distribution of these among the different types of institutions. Admittedly there is no quite consistent pattern in American higher education, whether general or professional, and few Americans desire that there should be. They like and believe in variety. But there is much more of a pattern than can be discerned at first look: and it emerges here sufficiently sharply. The second stage is a study of the elements which enter into the present costs of existing institutions and of the expenditures, capital and recurrent, which, carefully calculated on various hypotheses, will be necessary if those institutions are to hold their position and to meet the demands likely to fall upon them. Thirdly, an account is given of the present sources of income of the different types of institutions, and a projection of this account into the foreseeable future. Finally, there is a discussion of the policies to be pursued in securing economies and expanding income. At every stage, a mass of complex material is assembled and analysed with admirable fullness and clarity, and the argument enlivened with shrewd and penetrating comment. The British reader will find plenty of issues on which American experience marches with his own.

The finding is that, so long as general economic conditions remain broadly as at present, the pattern of income had better be left much as it is. State institutions, which have developed more rapidly than private institutions, and which now carry the greater part of the load, must look to increasing support from private sources and from their State legislatures. Private institutions, both colleges and universities, must look and can look confidently to fees, to endowments and capital gifts from benefactors and from sponsoring Churches or communities, to Foundations large and small, and to alumni associations. The major universities of both types may expect, particularly for their research programmes, important support from business corporations and from Foundations, and may expect also that the Federal Government will pay for services undertaken directly on its behalf. But experience suggests the need for care in settling the conditions under which grants or contracts are accepted: for future embarrassments are easily possible. In any event, the conclusion is clear —the solution of immediate and impending difficulties is not to be sought in the increasing participation of the Federal Government in the finance of colleges and universities. That way lies Federal control: and in the end that would mean "uniformity, mediocrity and compliance".

It is not for a British writer to express agreement or disagreement with the results of a study of a wholly American problem. But he may record his view that, in the preparation of this long series of reports, the commission, its staff, and the enabling Foundations have done a notable service to the university systems of many countries as well as of their own.

HECTOR HETHERINGTON

SOURCE-BOOK ON TELEVISION

Television

An Introduction to the Physical and Technical Principles of Television; with Comprehensive Descriptions of various Electrical Circuits. By F. Kerkhof and W. Werner. Translated by the late J. O'Connor Howe and G. Ducloux. (Philips Technical Library.) Pp. xv+434+38 plates. (Eindhoven: N.V. Philips Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd.; New York: Elsevier Press, Inc., 1952.) 50*s*.

AMONG the most rapid technical post-war developments has been that of television broadcasting, particularly in Great Britain and in the United States, where public services have been established for several years. While in many cases these developments have been described in scientific and technical papers, there has been a dearth of text-books dealing with the basic principles of the subject of television, for the use of students and professional workers engaged in this field. This gap is now at least partly filled by the book under review, the authors of which are principals of the television development laboratory of Philips Industries in Eindhoven. The book is a translation—and a very good one—of one of the series in Philips Technical Library: Dutch and German editions have already appeared and a French edition is in the course of preparation.

The subject-matter has been so arranged that a reader familiar with the basic principles of radio communication can assimilate the differing trends in the basic theory and technical practice of television. Much of the text is presented in a straightforward descriptive style, with good diagrammatic and photographic illustrations: more complete explanations in mathematical form are included where it is advantageous to do so.

Although the general purpose of the book is to explain the circuits employed in television receivers, it also comprises brief descriptions of the most important circuits used in studios and transmitting stations. The reader is led in a clear and straightforward manner through chapters dealing with the physical principles of electron scanning and the various types of camera tubes to a discussion of the means of transmitting and separating the information carried by the video signals. It is here that one finds set out the characteristics of the four systems that have been defined by the International Radio Consultative Committee. These include the systems

in use in Britain and in the United States, scanning at 405 and 525 lines, respectively, the so-called 'European' system with 625 lines, and the French experimental project using 819 lines.

Succeeding chapters deal in some detail with the application of relaxation oscillations to the pulse generators used for line and picture synchronization, and to the power supplies required for these. The important subject of wide-band amplifiers correctly occupies about a quarter of the book; and the later chapters deal first with the optical problems of picture presentation, including both direct viewing and projection systems, and second, with a very brief and not quite up-to-date survey of colour television. The book concludes with a chapter describing in some detail, and with complete circuit diagrams and lists of components, two television receivers for positive and negative modulation, respectively, suitable for the British 405-line system and for the 625-line standard. Although there is a short chapter on aerials and some discussion on propagation problems in relation to television, it is clear that these subjects cannot be dealt with in any detail without making the book larger than the authors may desire. It is to be hoped, however, that they may be encouraged in a future edition to make use of the extensive publications which have appeared in the literature on television since 1950.

As the first full modern study of the basic aspects of the subject, this work can be recommended with confidence both for general reading and, with the aid of the excellent bibliography provided, as a constant source of reference for more detailed study.

R. L. Smith-Rose

HIGH-ENERGY PHYSICS

High-Energy Particles

By Prof. Bruno Rossi. (Prentice-Hall Physics Series.) Pp. xiii+569. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1952.) 65*s*. net.

It will generally be agreed that the central problem of physics during the past twenty-five years has lain in the identification of a set of elementary particles and the establishment of their properties in interaction. In this book Prof. Bruno Rossi sets out to survey the information gathered about these particles from high-energy experiments. His interest is not with complete atoms or nuclei, but essentially in the interactions of individual particles—photons, electrons, nucleons and the variety of mesons—from a study of which one hopes to discover the laws governing the ultimate structure of things.

The general plan of the book is that the first six chapters, apart from some description of the properties of the elementary particles, are devoted to electromagnetic interactions. The remaining two chapters (amounting to nearly two hundred pages) are devoted to the interactions of nucleons and mesons. There is a difference of treatment in the two sections, in that, whereas an effort is made to present as full a theoretical account of the electromagnetic processes as can be given without the use of relativistic quantum field theory, no attempt is made to provide any theory of nuclei or mesons. Anyone familiar with the present state of meson theory must sympathize with this policy. However, there are various general considerations of meson theory which are likely to remain valid, and the comprehensive character of the book would have been improved if some account of them had been included. As it is, the later chapters of the book appear somewhat disconnected, as compared with the earlier ones.

After a short introductory account of the known elementary particles, and of the general character of the cosmic radiation, Chapter 2 is devoted to the theory of electromagnetic interactions. Here we are on well-established ground; the difficulties are those of exposition. Any theoretical physicist who has undertaken to expound, for example, the theory of Compton scattering to his experimental colleagues is aware how real these are. The classical Thomson cross-section can be derived, but a quantum theoretical derivation of the Klein–Nishina formula is accepted as being beyond the tolerable requirements of an experimentalist. The tendency is just to quote the formula and, in words or graphs, describe its consequences. This path is in many cases followed by Prof. Rossi, and he is very successful in the clarity of his exposition (though I must disagree with his statement on p. 13 that no classical analogue exists to the Compton scattering). In other cases, as in the treatment of the ionization produced by the passage through matter of fast charged particles, or of the production of bremsstrahlung, where there are semi-classical descriptions available for the phenomena, these are well presented. Incidentally, the author's interest in statistical fluctuation problems is shown by a good account of what is sometimes called the 'Landau effect'—the fluctuations in energy loss by collision.

There follows a brief description of the mode of operation of most of the detectors used in nuclear physics, sufficient to provide a background against which the experimental material can be assessed. Chapter 4 contains a review of some of the basic properties, including the decays, of the various elementary particles. In part this account is historical: thus the cosmic ray experiments leading to the discovery of mesons and their decay are described as well as the later experiments with artificially produced mesons which have enabled the properties to be more precisely established. This chapter also contains a short account of heavy mesons, now rather out of date, which serves to illustrate the difficulties of giving in book form an adequate account of a fast-developing subject.

The next two chapters are devoted, respectively, to cascade shower theory and to a rather miscellaneous collection of experiments on high-energy electromagnetic interactions. The book ends with the two chapters on nuclear interactions—the first dealing with artificial sources and the second with cosmic radiation. An interesting feature of this last chapter is an admirable set of thirty-two photographs of high-energy nuclear events. The information from artificial sources is complete up to early 1951. It is perhaps in this chapter on artificial sources that the need for some theoretical interpretation of the meson phenomena is most strongly felt.

In conclusion, Prof. Rossi is to be congratulated on providing such a full survey of a large subject within a single volume. As a readable account of certain of the more complete topics in high-energy physics, and a reference work describing the more recent experiments up to 1951, this book can be warmly recommended.

J. C. Gunn

A Source Book in Chemistry, 1400–1900

Edited by Henry M. Leicester and Herbert S. Klickstein. (Source Books in the History of the Sciences.) Pp. xvi+554. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 64*s*.

FOR this contribution to the series "Source Books in the History of the Sciences", an international group of scholars acted as advisers. The selection employed, restricted "to material which illustrates the development of chemical theory only", pays frequent tribute to the acumen of "The Alembic Club Reprints" and Ostwald's "Klassiker". Some one hundred and forty excerpts are provided, with brief notes on the eighty authorities who are cited in the list of contents.

Even so prosaic an anthology will arouse contention. Some will look for Lomonosov, Higgins, Stas or Newlands; others will note the omission of original papers on kinetic theory; and many will argue that the discovery of the inert gases has influenced "the development of chemical theory" much more than Agricola's recipe for mineral acid. It would be interesting to know on what system Dulong is so distinguished to the disadvantage of Petit, why "Wöhler and Liebig" on the benzoyl radical appears under Wöhler, and why Dalton is represented in part by a lengthy extract from Thomas Thomson. Richter is illustrated by a "Table of Richter's equivalents" which is in fact a table calculated and composed by E. G. Fischer. There is a degree of confusion on the origin of footnotes (author, translator, editor) and a few ill-advised intrusions in the text, as, for example, an unidentified one "(i.e. carbon monoxide)" in a paper by Cavendish (p. 148). There are a useful author index, and a bibliography of biographies. There is no subject index.

The translations specially made are in general business-like and clear. The contemporary translations of older works are charming and well chosen. There are notably few misprints. There is great advantage in this collection of an English version of so many pregnant essays between one pair of covers, and the volume is a proper candidate for the staff bookshelf in every place where chemistry is seriously taught.

ANDREW KENT

The Phase Rule and its Applications

By Alexander Findlay. Ninth edition, by Prof. A. N. Campbell and Prof. N. O. Smith. Pp. xii+494. (New York: Dover Publications, Inc., 1951.) Paper, 1.90 dollars; cloth, 5 dollars.

CONSIDERED by some as a classic and by many as the standard work, Findlay's "Phase Rule", when first published in 1904, had 313 pages; in the eighth edition of 1938 there were 327 pages. Owing to unceasing research and the shift of emphasis, the eighth edition no longer reflects a comprehensive view of the subject. Accordingly, the authors—they are more than revisers—have rebuilt the book from a new selection of available knowledge. Their own contributions to the literature and their awareness of the needs of students make them well fitted for the task. They have eliminated matter of diminished importance, greatly increased the number of references and illustrations and much extended the range of topics discussed.

Thus the authors give entirely new treatment both of ternary liquid – vapour equilibria and of solid solutions in ternary systems. Included also are: phase changes in the cooling of ternary melts, quinary systems of salts and water, critical phenomena in binary systems, salting out, soap systems, fuming liquids, the free-energy basis of ternary and condensed systems, and the experimental determination of freezing-point diagrams.

The clear style of writing, the explanatory notes, the graphical thermodynamic deductions of some familiar equilibrium diagrams, and the frequent use of solid models should afford valuable help to students. The extended scope and extensive changes make this in all but name a new book and it should rank as the standard work in English on this subject.

G. F.

Statistical Year-Book of the World Power Conference

Annual Statistics for 1948–1950, with some Supplementary and Revised Statistics for Earlier Years and Available Statistics for 1951; some Additional and Revised Data on Resources. Edited, with Introductory and Explanatory Texts, by Frederick Brown. Pp. 163. (London: World Power Conference, 1952.) 35*s*. net.

THE third post-war issue of the "Statistical Year-Book of the World Power Conference", which has now become a biennial publication, gives statistics for 1948–50 with additional and revised information for earlier years and the available statistics for 1951. There are also some additional and revised data on resources. Like its predecessors, the present issue contains statistics of the productions, stocks, imports, exports, consumption of power and sources of power in all the countries of the world from which it was possible to obtain information. Data on resources are included only where important additional information has become available. The power sources are coal, lignite, peat, coke, manufactured fuel, wood, gas, water-power and electricity. Most of the statistics were supplied by the national committees of the World Power Conference; but, to a substantially greater extent than in previous issues, statistics have been reproduced from publications of the United Nations and from government sources. Preliminary tables give the area and population of all countries; the population figures are estimated for each year during 1948–51 and also for the last census. All measurements are on the metric system.

The Ant World

By Derek Wragge Morley. (Pelican Books.) Pp. 191+8 plates. (London: Penguin Books, 1953.) 2*s*.

THE publishers of Pelican books have again performed a useful service to natural history by the publication of this book on ants. Wragge Morley began to study ants when he was fourteen, read his first research paper two years later, and has been an 'ant man' ever since. Now, at thirty-three, he brings his long experience together in a form which is both interesting and scholarly to describe a group of insects which, although little known, comprises some fifteen thousand species—a number which is constantly being enlarged by the discovery of new ones. Harvesting ants, soldier ants, mushroom-growing ants, spinning ants, ants which live in small and large communities, ants a millimetre long and ants 3½ in. long, are all described from the points of view of history, behaviour, ecology and physiology. Morley also pays attention to the considerable economic importance of ants to man. The book is admirably illustrated with line-drawings and photographs.

T. H. H.

STONEHENGE IN THE LIGHT OF RECENT RESEARCH

By R. J. C. ATKINSON

Department of Prehistoric Archæology, University of Edinburgh

DURING June and July of this year, excavations were undertaken at Stonehenge by Prof. Stuart Piggott, Dr. J. F. S. Stone and myself as part of research planned with the view of the eventual publication by the Society of Antiquaries of a definitive report on the monument and its associated structures. The season's work had three objectives: first, to examine in detail the course of the Stonehenge Avenue, and in particular to confirm or disprove the existence of the branch alleged by Stukeley in 1740 to run towards the Cursus, which has not since been reliably observed; second, to seek evidence for the date and purpose of the two rings of pits, known as the *Z* and *Y* Holes, which encircle the stones; and lastly, to examine the relationship of the Heel Stone to the Avenue within which it stands, and to establish more firmly the position of both in the sequence of construction.

At the first eastward bend in the Avenue, some 1,700 ft. north-east of Stonehenge, careful observation of the surface, aided by probing and by electrical resistivity surveys, revealed no trace of the supposed branch. Two ditches were found, however, and proved by excavation, which corresponded closely with the position recorded by Stukeley for his branch. Neither was connected with the Avenue proper nor with the other; but it is clear that, with the help of a little imagination, they could, and almost certainly did, mislead Stukeley into asserting that they formed a branch of the Avenue leading in the direction of the Cursus. Their date is unknown; the western ditch is upwards of 500 ft. in length, and may be a boundary ditch of the first millennium B.C.; the eastern ditch, only some 100 ft. long, is clearly of more recent date and was shown to have been dug after the ditches of the Avenue were completely silted up.

The *Z* and *Y* Holes chosen for examination (*Z* 16 and *Y* 16) lie south-west of the stones, immediately west of the axis. They proved to be oval pits, 5–6 ft. long and 4 ft. wide, with sides sloping steeply to a flat bottom, sub-rectangular in plan. The chalk sides themselves were almost unweathered, and were covered by a few inches of much-weathered chalk rubble, the primary silting formed by the initial disintegration of the sides during the first few years of exposure. The remainder of each pit contained secondary earthy silting, extending almost to the bottom, with a number of flint nodules in the lower levels. Finds from the primary silting comprised a single sherd of pottery, dating from the second millennium B.C., and a few very small chips of bluestone, but no sarsen fragments or pottery of later date. The secondary silt yielded numerous chips of both sarsen and bluestone, and pottery of the first few centuries B.C. and A.D.

The contents of the holes showed conclusively that, once dug, they were left open, and that the secondary silt accumulated very slowly over a period of many centuries. In view of the known ability of earthworms to bury small objects, the presence in this secondary silt of Iron Age pottery, even at low levels, can therefore no longer justify the ascription of the *Z* and *Y* Holes to that period. That the holes were dug after the erection of the sarsen stones was already known from the excavations of 1919–26; the new excavation suggests that they were dug before the erection of the bluestones in their present setting. For, had the dressing of the bluestones taken place before the excavation of the holes, the quantity and size of the bluestone fragments in the early silting would almost certainly have been greater; the scarcity and small size of the chips actually found may be ascribed more convincingly to abrasion between bluestone monoliths which were being manhandled on the site but had not yet been dressed to shape or erected.

The purpose of these holes is still unknown. It is noticeable, however, that they are of a suitable size and depth to serve as emplacements for the existing bluestones; and it can scarcely be a mere coincidence that their number, fifty-nine (one hole, *Z* 8, is missing, its position being occupied by a sarsen stone which had apparently fallen before the holes were dug), is identical with the best estimate of the original number of bluestones in their present setting (forty in the circle, nineteen in the horseshoe). It may thus be suggested, as more than a pure speculation, that the *Z* and *Y* Holes were dug, some time in the latter half of the second millennium B.C., as sockets for the bluestone monoliths; that this purpose was abandoned, for reasons unknown, before their erection; and that the holes were left open, while the bluestones were afterwards dressed and erected in their present positions.

At the Heel Stone, work was confined to a single trench running from its south-east side across the ditch which encircles it and through the adjacent eastern bank and ditch of the Avenue. It was found that the stone had been erected from the west, and that, as at Avebury and elsewhere at Stonehenge itself, the opposite side of the hole had been furnished with a row of upright anti-friction stakes, designed to prevent the toe of the stone from digging into the side of its socket when it was being hauled upright. Decayed remains of these stakes were found *in situ* against the south-east face of the stone at its base, while above, where soil had gradually filtered in to replace the rotted wood, several fragments of Beaker pottery were discovered. At the same level were numerous fragments of sarsen and bluestone, but none occurred lower down. The pottery can be dated 1700–1600 B.C.; and when allowance is made for the decay-period of the stakes, it may be concluded that the stone was erected, at latest, around 1700 B.C., and very possibly earlier. It is therefore probably contemporary with the earliest constructions on the site, the ditch, bank and Aubrey Holes. A carbon-14 test of charcoal samples excavated from Aubrey Hole 32 in 1950

gave the date of this earliest phase as 1848 B.C. ± 275 years.

The narrow, steep-sided ditch surrounding the Heel Stone appears to have been filled up deliberately shortly after it was dug. In this filling was a single chip of unweathered bluestone (rhyolite). As the ditch was presumably dug immediately after the erection of the stone, and as the latter appears to belong to the earliest monument, it follows that at least one foreign stone is likely to have formed part of this monument. There is evidence, however, that at this time the majority of the bluestones stood as a separate monument some twelve hundred yards north-west of Stonehenge and were not moved to their present site until after the erection of the sarsen stones.

The surface of the deliberate filling of the Heel Stone ditch was covered by the tail of the Avenue bank, which shows that the latter, and its ditch, must be later than the stone. The absence of fragments of sarsen and bluestone from the bank material and from the primary silting of the ditch strengthens the hypothesis that the Avenue antedates the erection of the stones of Stonehenge.

The date of the erection of the sarsen stones, hitherto uncertain because based on circumstantial evidence only, can now be placed with some confidence around 1500 B.C. This has been made possible by the chance discovery of representations of Bronze Age weapons on two of the stones. These comprise a hilted dagger and four axe-heads on Stone 53, and at least eleven similar axe-heads on Stone 4. The axes are all of the 'hammer-flanged' type, characteristic of the British Early Bronze Age, and manufactured, chiefly in Ireland, from 1600 B.C. to 1400 B.C. The presence here of these obviously ritual representations points to the existence in Britain of an axe-cult comparable to the cult of the double-axe in the contemporary Minoan civilization of Crete. That there may be some actual connexion between these cults is suggested by the dagger. This is unlike any weapon current in the Bronze Age of Britain or Western Europe, but is an accurate representation of a type used in the central Mediterranean from 1600 B.C. to 1500 B.C. and best paralleled from Shaft Grave VI at Mycenæ. Its exotic nature makes it highly probable that the carving was executed at Stonehenge within the lifetime of someone who was personally familiar with this type of weapon in its homeland; in other words, not later, say, than 1470 B.C. It follows, therefore, that the sarsen stones were erected before this date. It may be added that this dagger affords presumptive evidence that the architect of Stonehenge was himself a Mycenean, a suggestion which has already been prompted by the architectural refinements exhibited by the monument.

The evidence reviewed above, when added to that from previous excavations, makes it possible to set out, with greater confidence than before, the following probable sequence of phases of construction at Stonehenge. (1) 1900–1800 B.C.: Construction of ditch, bank and Aubrey Holes; erection of Heel Stone and at least one bluestone, perhaps in the centre. (2) Construction of the Avenue. (3) 1500 B.C.: Dismantling of bluestone(s) of phase 1; erection of the sarsen stones. (4) Digging of the *Z* and *Y* Holes, possibly for reception of bluestones derived from the dismantled 'Bluestonehenge' twelve hundred yards away. (5) Plan of phase 4 abandoned; bluestones dressed and erected in their present positions.

INTERNATIONAL FEDERATION OF UNIVERSITY WOMEN

ELEVENTH CONFERENCE

"HUMAN Values in the Technical World" was the theme of the Eleventh Conference of the International Federation of University Women held recently at Bedford College, London. The theme is topical and appropriate for a Federation the aim of which is the encouragement of scholarship and the promotion of understanding among university women of the different nations of the world. Two methods of approach were used: a series of three public lectures by distinguished speakers, each of whom dealt with a special aspect of the subject, and discussions by small groups of Conference members of different nationalities and varied interests.

The conference was attended by about 750 members from twenty-eight countries, and included representatives of almost every kind of profession from the director of the Meteorological Office in Iceland to an Italian woman graduate who is a farmer. Conference members were pleased to hear that Dr. Louise Pearce, third vice-president, had recently been honoured by the award of the Order of the Lion and a gift of 10,000 dollars from the Belgian Government. This award was for her share in the discovery of tryparsamide, a drug which has proved extremely valuable in the treatment of sleeping sickness in the Belgian Congo.

It was announced at the conference that nine international fellowships will be awarded in 1954. There will be two international federation fellowships, named the Ida Smedley Maclean Fellowships in memory of the late Mrs. Smedley Maclean, an English biochemist and the originator of the Fellowship Fund. A new Irish Fellowship is to be given in honour of Prof. F. E. Moran, president during 1950–53 and the first Irish president of the Federation, and six fellowships have been endowed by members of the American Association. A fund for the provision of one or more fellowships and grants to be called the Winifred Cullis Fund is to be established in honour of Prof. Winifred Cullis, one of the founder members of the Federation. Since its foundation in 1920 the International Federation has awarded seventy-eight fellowships and eighteen grants to scholars of twenty-four different countries.

The officers of the International Federation for 1953–56 were elected at the conference, and the new president is Miss Dorothy Leet, of the American Association of University Women, who is president of Reid Hall, the American Education Centre in Paris. Since 1949 Miss Leet has been the International Federation's consultant to Unesco. The three vice-presidents are: Dr. E. C. Batho, principal of Royal Holloway College, University of London, Mrs. Schouwenaar-Franssen, of the Netherlands, and Mrs. Dorothy Forsaith, of Australia. The new honorary treasurer is Ing. Adèle Racheli, of Italy, whose special field of study is mechanical engineering and who is a patent agent with offices in Milan, Rome and Switzerland.

The three public lectures on the theme, "Human Values in the Technical World", accepted as a fact the interdependence of the nations of the world, brought about by science, and the problem studied was the means whereby man might reach his highest excellence in these conditions. Speaking on "London

Town", Sir Henry Self, president of the British Electrical Development Association, traced the part London has played towards scientific development in its impact on human thought and values. He expressed the fear that science has made this earth so worth-while a habitation that it opens up the menace of "soft living" and has at the same time produced devastating means of destructive war. Scientific achievement has been attained by self-sacrificing effort, stirring adventure and resolute pursuit of truth for its own sake; these are precisely the human values threatened to-day. The sweeping advances made in the study of astronomy, mathematics and physics at the time of the Renaissance prepared the way for the revolution of the following century which produced a scientific interpretation of life and the world in terms of mechanistic determinism and materialism. At the same time the Reformation asserted the responsibility of the individual. The movement began as an adventure of man's personality responding to his intellectual confidence that truth must prevail. But gradually during these centuries God was reduced successively to the role of maintaining order, and then to the point where there was "no need of such a hypothesis". Gradually, however, the idea that the universe is made up of living objects in full and intimate interaction took shape. Sir Henry traced the history of experimental work in the nineteenth century, mentioning particularly work in spectrum analysis. He mentioned the controversy about the theory of evolution and said that scientists to-day recognize a fundamental harmony of things. Science, concluded Sir Henry, is one channel by which God speaks to man and conscience is another. This is the way whereby human values might be preserved in the technical world.

The second lecture, "Science and the Discovery of Human Values", was given by Prof. Arthur H. Compton, chancellor of Washington University. He does not support Sir Henry Self's fear of the threat of barbaric power. Technology in itself, he said, gives its distinctive meaning to life by revealing the interdependence of all men and all nations. The goal of the scholar is the vision of excellence; technology gives him the power to make the lives of others excellent and to enable them to grow to their best, thus finding his own fulfilment. Long ago Pythagoras said that the scholar sought to learn how the world was made in order to find a better way of life. We of this age have been brought face to face with the vastness of the universe; thanks to the advances of technology it is in our power, and, indeed, it is our responsibility, to affect the lives of others. It is a matter of vital significance that adaptation to life in the modern world demands increasing emphasis on the human virtues: success in science means loyalty to truth, concern for reliable knowledge; technology calls for the skilled expertness that comes from experience combined with specialized knowledge; work in any social organization requires willingness to co-operate, consideration for one's fellows and a desire to promote the task on which the group is engaged. Banishing the spectres of starvation and premature death from disease is not enough: the essential dignity of man is all-important and each individual must have the opportunity of playing his part and taking responsibilities. Science improves the means with which we work towards our goal and enlarges our choice of goal. Losing ourselves in the effort to give others the opportunity to find each his own excellence is a condition of survival; so can we find our own souls and so can the humanities be preserved.

"Organization and Personality" was the subject of the address given by Prof. P. C. Mahalanobis, statistical adviser to the Government of India and vice-chairman of the United Nations Statistical Commission. He said that the technical world and the advances of science must be accepted; there is no retreat, but the problem is to adapt the personality of man so as to attain its highest perfection in a world of ever-increasing power. The basis of the development of personality lies in the relationships of human beings; these relationships develop gradually, from the home to the school, and widen from the national to the international level. Social organization in the machine age is tending to the submergence of personality: skilled labour gives place to unskilled, craftsmanship is displaced, automatic controls take over. This is the price we are paying for technical power. Conflicts arise on every level—between capital and labour, town and village, between nations and blocks of nations. Science can enable us to provide more food, more clothes and medicines. At every new stage of scientific development humanity is faced with a crisis, and a growth of personality is needed to meet it. We have to learn to use our power for the general good. Some of the basic biological and emotional human values remain unchanged everywhere. Our "institutional values", such as means of preparing food, can develop, and here science increases the scope greatly. Cultural unities, such as that of Europe, represent a "national value". International contacts and values have become a necessity of the modern world as we are drawn ever closer together by technology. The danger to modern society lies in making a social merit of having more and more things, but herein lies a source of unbalance and greed. We must learn to grow into that wholeness of personality which finds its self-expression in a joy in things and not merely in possessing. Our goal must be to transcend the little cell and to work towards a unity in diversity, not by eliminating our differences as nations, but by creating a deeper harmony in humanity and friendship.

The main theme was divided into various aspects for study by groups of conference members—a balanced education for full citizenship, methods of mass education, the ethical basis of human values in a technical age, the human factor in the organization of work and the impact of modern techniques on non-industrial communities. In reporting the findings, Dr. Marguerite Henrici, organizer of the groups, said that they are not yet the official opinions of the Federation, but the results of discussions during the conference. Once again, naturally, the importance of the individual was emphasized. The first group recommended that each individual should be educated to think clearly and effectively, to form critical judgments, to practise a concern for the welfare of others, since citizenship demands a realization of a duty to others near and far. A balance between intellectual and social education should be maintained, and in the living community of the school each individual should have his rights and responsibilities. While a just pride in the national heritage is to be encouraged, the obligation to the wider international community must not be forgotten. Small classes and more teachers are desirable.

Mass education entails education through life: any kind of rich and varied experience which evokes a

greater appreciation of life contributes to this. Again, the value of the individual was stressed and it was recommended that the Federation should use its influence to make mass media such as films and radio less sensational and more inspiring to the individual. Cheap means of printing and the suppression of over-nationalistic text-books would be helpful, too, as would schemes for the exchange of students and teachers between rural schools and others. It was further recommended that the value of the humanities in general education should be emphasized, while recognizing the importance of scientific and technological factors.

The group which discussed the ethical basis of human values came to the conclusion that the essential value at which man ought to aim is the increasing development of those powers of soul and spirit which contribute to build up a harmonious personality and society. Special efforts should be made to counteract the levelling tendencies of technology by stressing the necessity of individual decision.

In studying the organization of work, a further group considered it should be so arranged as to protect the personality of the individual. Suggested practical means to this end were: vocational guidance for all, and an effort to find ways of overcoming the effects of monotonous work.

The fifth group, in dealing with the impact of modern techniques on non-industrial communities, reached the conclusion that the greatest precaution should be used in the introduction of foreign ways and standards of living into non-industrial countries. Accepting the fact that technology's greatest contribution lies in the service of others, this group stressed that this service can be performed on the spiritual plane as well as on the material.

In summing up the findings of the groups, Dr. Henrici said that in this time of transition and crisis the threat to human values comes not only from external nature but also from civilization itself. It is the task of educated people everywhere to seek the truth with fervour and to follow it with courage. It is a more difficult task than to live according to the precepts of the loud-speaker. The power of decision lies with each individual and therefore with the human race. The individual is not himself responsible for the decisions taken by the race, but in living his daily life he can influence them for good or ill.

PARTICLES OF COSMIC RADIATION

An international conference on cosmic radiation, organized by the University of Toulouse and under the patronage of the International Union of Pure and Applied Physics, was held at Bagnères de Bigorre during July 6–12. The president of the conference was Prof. P. M. S. Blackett, and the secretary-general Prof. L. Leprince-Ringuet. In opening the conference Prof. Blackett said that it had been decided to restrict the discussion in the main sessions to the narrow but important field of *V*-particles and heavy mesons. It was hoped thus to make an effective contribution to a subject of great contemporary interest for the development of our knowledge of elementary particles. This aim was reflected in the attendance at the conference, and among the two hundred members were representatives of many of the laboratories actively engaged in the subject.

The main sessions of the conference were divided into two groups. In the first seven, the experimental facts were described and discussed; in the last three, the whole body of evidence was reviewed, and an estimate made of the present state of knowledge. In describing the most important results and conclusions, it will be convenient first to consider particles more massive than the neutron; and secondly, those intermediate in mass between the π-meson and the proton.

Particles Heavier than the Proton

It is now established that the heavy neutral *V*-particles discovered by Rochester and Butler (V_1^0) decay into a proton and a negative π-meson with an energy release of about 37 MeV.:

$$V_1^0 \rightarrow P + \pi^-; \quad Q = 37 \pm 3 \text{ MeV}.$$

The mean lifetime of the particles is $\sim 3{\cdot}3 \pm 1{\cdot}0 \times 10^{-10}$ sec. There is good evidence that they can be produced in nuclear interactions in which the available kinetic energy is insufficient to provide all their rest-mass. They are therefore believed to result from the transformation of nucleons, and, in this sense and since they decay into protons, they may be termed 'excited nucleons'. An outstanding problem of great interest is whether the particles are commonly produced singly or in pairs, a question which it may be possible to resolve by determining the minimum energy required for their production in the collision of protons and π-mesons with nuclei.

There is now strong evidence from work with photographic plates for the existence of charged particles more massive than the proton, each of which decays into a neutral particle and a π-particle according to the equation:

$$J^{\pm} \rightarrow N + \pi^{\pm}.$$

If the secondary neutral particle is a neutron, the release of energy, Q, is ~ 130 MeV., and the mass of the parent particle, m_J, $\sim 2{,}360\ m_e$. Five examples have now been observed in photographic emulsions, in three of which the primary particles decay in flight. The mean lifetime appears to be of the order 4×10^{-11} sec. There is tentative evidence for an alternative mode of decay $J^+ \rightarrow P^{\pm} + \pi^0$, but this remains to be confirmed.

There is good evidence from experiments with Wilson chambers, but also not decisive, for a massive charged particle which decays into a negative π-meson and a neutral V_1^0-particle according to the equation $\Lambda^- \rightarrow V_1^0 + \pi^-$. In addition to the original event, which can be interpreted in this way, found by Armenteros *et al.*, three similar examples have been observed by Leighton and his colleagues. It is possible that the particles J and Λ are identical, in which case their mass is $\sim 2{,}700\ m_e$.

Further examples have now been observed of the process, first observed by Danysz, in which a heavy nuclear fragment ejected from a nuclear explosion reaches the end of its range and disintegrates. It appears that π-mesons are frequently emitted as one of the products of the secondary disintegration. It is possible that these events are due to the presence, in the nuclear fragment, of a nucleon in an excited state; but alternative explanations cannot at present be excluded.

Heavy Mesons

Of the heavy charged mesons with masses in the interval 900–1,500 m_e, it is established that particles of mass 970 ± 5 m_e exist which decay into three π-mesons. The particles are referred to as τ-mesons; $\tau \rightarrow 3\pi$. Seventeen examples have been recorded in photographic plates, in all of which the particles decay 'at rest'; and of the fifty-one secondary π-particles from these events, eleven have been observed to reach the end of their range. Eight of them have thus been identified as positive, and three as negative, π-particles. This fact, and the observed co-planarity of the directions of emission of the three π-particles from each decaying τ-meson, make it probable that all, or most, of the particles which decay in this mode when arrested in photographic emulsions are positively charged. A few examples of the decay 'in flight' of τ-mesons have been observed in Wilson chambers. In one case, the parent particle was negatively charged. The τ-mesons observed in cloud-chambers occur infrequently compared with charged V-particles, $N_{\tau^\pm}/N_{V^\pm}$ being $\sim 1/20$.

It is established that some heavy mesons, when arrested in photographic emulsions or in metal plates, decay with the emission of μ-mesons. This follows, on one hand, from the direct observation of the β-decay of the secondary mesons, or from mass-measurements in photographic plates; and, on the other hand, from experiments with expansion chambers in which the secondary particles are observed to traverse a total distance equal to several 'interaction-lengths' in metal plates, without giving decisive evidence for a nuclear interaction. The energy of the secondary μ-meson varies widely—from very low values up to at least 200 MeV. It is therefore necessary to assume that the μ-meson is accompanied by at least two neutral particles. Particles decaying in this mode are referred to as $\varkappa$-mesons; $\varkappa \rightarrow \mu + 2$ neutral particles.

Experiments with photographic plates suggest that heavy mesons may sometimes decay with the emission of a π-meson of energy ~ 110 MeV. The evidence is not decisive; it receives no support from observations with cloud chambers, but the latter are not inconsistent with the view that heavy mesons sometimes decay in this mode. Since the energy of the secondary π-mesons appears to be unique, the transformation is written, tentatively: $\chi \rightarrow \pi + 1$ neutral particle.

Experiments with Wilson chambers indicate that photons, with energy 100–200 MeV., are sometimes produced in the decay of heavy particles. The photons, detected by the small cascades of electrons to which they give rise, appear to recoil from the secondary charged particle. The observations are compatible with a decay of the parent into two particles only, a charged particle and a photon, but this interpretation does not necessarily follow from the observations and must be treated with reserve.

All the direct measurements, made hitherto, of the mass of heavy charged mesons which come to rest and decay into a single charged particle are consistent with the view that all the particles have masses near, or equal to, that of the τ-meson. This result, if taken alone, makes it permissible to assume, tentatively, that the particles distinguished phenomenologically as τ-, $\varkappa$- and χ-mesons represent alternative modes of decay of particles of a single type, but it does not prove this assumption to be true.

There are two pieces of experimental evidence which suggest that among the heavy mesons are some which have masses significantly greater than that of the τ-meson. The first piece of evidence is the observation of the maximum energy of the μ-mesons produced in the decay of $\varkappa$-mesons. If the τ-meson has a mass of 970 m_e, the maximum energy of the μ-mesons, set by the conservation laws and assuming both neutral particles to have negligible rest-mass, is ~ 150 MeV.; the corresponding values of momentum, p and $p\beta$, are ~ 233 MeV./c and ~ 211 MeV./c, respectively. Observations by expansion chamber give no evidence for secondary particles with energies greater than this limit. On the other hand, measurements with plates provide several examples in which the secondary particles appear to have values of $p\beta$ substantially greater than that corresponding to the limit. It is well known that determinations of $p\beta$ by the scattering method can give high values due to statistical fluctuations. The probability that the high values in question are to be so interpreted appears, however, to be small—less than 1 per cent. To bring these observations into accord with the assumptions that $\tau \equiv \varkappa$ or that $m_\tau \sim m_\varkappa$, it is necessary to assume either that there are unsuspected sources of error in the measurements, or that there are alternative physical processes involved. It is possible, for example, that some of the heavy mesons observed to decay are negatively charged. If weakly interacting, they might then decay while moving with high velocity in bound orbits around nuclei; and if so, the energy spectrum of the secondary particles might be greatly modified as compared with that of the positive particles. Such an effect is believed to exist in the case of negative μ-mesons captured by nuclei of low atomic number.

The second piece of evidence is that measurements by the photographic method of the masses of heavy mesons directly emitted with great velocity ($\beta \sim 0{\cdot}7$) from nuclear disintegrations give a mean value of about 1,210 m_e; and there are no individual values in the mass spectrum less than 950 m_e. It is reasonable to assume tentatively that the fast heavy mesons created in the high-energy events are identical with those with approximately the same velocity, observed in experiments with Wilson chamber, which appear to have masses of the order of 920 ± 40 m_e. The later values are not significantly different from those of the slow particles already discussed.

The above apparent contradiction in the mass values can be resolved, and the assumptions that $\varkappa \equiv \tau$, or that $m_\varkappa \sim m_\tau$, can be maintained, if it is assumed that the mass measurements by the photographic method are subject to unrecognized systematic errors. Alternatively, it may be assumed that the heavy particles of mass $\sim 1{,}210$ m_e are indeed emitted from high-energy disintegrations, but that they decay in flight, with a mean lifetime of the order of $\sim 3 \times 10^{-11}$ sec., and transform into particles of mass $\sim$ 970 m_e. In general, such a transformation should lead to a deviation in the track of the particle, but the deviations may be small if most of the difference in mass appears as the rest-mass of the secondary neutral particle or particles.

Nuclear Capture of Negative Heavy Mesons

There appears to be a large disparity between the number of heavy mesons observed to decay in nuclear emulsions and the number which interact with nuclei. The evidence obtained with Wilson chambers shows that positively and negatively charged V-particles occur with approximately equal fre-

quency. Since the particles appear to be directly created in nuclear interactions, it would be reasonable to assume that they are strongly interacting. If so, when arrested in solid substances, they would be expected to produce observable disintegrations. Very few such disintegrations have been found, although many laboratories have made a well-directed search.

It is difficult, at present, to make a reliable estimate of the ratio of the number of heavy mesons decaying to the number producing a recognized nuclear interaction because of the different methods of search employed in different laboratories, but a conservative estimate suggests that it is at least five to one. If the particles observed to decay are all positive, it then follows that only about a fifth of the negative heavy mesons, when arrested in photographic emulsions, produce effects due to nuclear capture comparable with those due to negative π-mesons. Alternatively, some of the particles may be weakly interacting so that, as with μ-mesons, some of them, even when negative, may decay.

Neutral Heavy Mesons

Of the neutral particles less massive than the proton, it is now established that there is one type which decays into two charged mesons, one of which is a π-particle, and probably both: $\theta^0 \rightarrow \pi^+ + \pi^-$; $Q = 214$ MeV. The mean lifetime of these particles is $\sim 10^{-10}$ sec. If the secondary charged particles are both π-mesons, the mass of the parent particle $m_{\theta^0} = 971 \pm 10\ m_e$, a value equal to that of the τ-meson within the limits of experimental error.

There is evidence for other types of heavy neutral particles, referred to as V_2^0, which appear to decay into a heavy meson and a light meson (π or μ), but it remains to be confirmed.

The conference gave an impressive demonstration of the great profit to be derived from meetings between representatives of different scientific traditions. The presence of many experts in the various experimental methods ensured a most informed and critical approach to the important questions which were reviewed, and the conference was memorable for the very serious level of the discussions, and the cordial relations between its members.

C. F. POWELL

PROGRAMME OF AUSTRALIAN ANTARCTIC EXPLORATION

By SIR DOUGLAS MAWSON, O.B.E., F.R.S.

DURING the past six years, the Commonwealth Government of Australia has, through its organization known as the Australian National Antarctic Research Expedition, prosecuted scientific investigations in the Far South. As long ago as 1939 tentative plans were formulated to continue with the scientific exploration of Antarctica. At that time it was proposed to organize such work under the ægis of the Australian universities, with the expectation of maintaining one or more shore research stations on the Antarctic mainland, there to be serviced from Australia by employment of the *Wyatt Earp*, which in 1939 the American explorer Lincoln Ellsworth had disposed of to the Commonwealth Government. However, the advent of war postponed such proposals and the *Wyatt Earp* was placed under the care of the Royal Australian Navy.

At the termination of hostilities the matter was again pressed, representations to the Government being made by the National Research Council.

Eventually, early in 1947, the Government agreed to meet the cost of refitting the *Wyatt Earp* as required for explorations in Antarctica and to establish and conduct research stations in the sub-antarctic on both Macquarie Island and Heard Island: the former about 900 miles S.S.E. of Hobart, the latter about 2,500 miles S.W. of Perth. Group-Captain Stuart Campbell, who had had Antarctic experience as chief aviator of the B.A.N.Z.A.R. Expedition of 1929–31, was seconded to be chief executive officer in command of the undertaking. Much was accomplished in that first year. On Macquarie Island and on Heard Island well-equipped stations were established and operated during the year 1948. Also in the summer of 1947–48, with Campbell on board and a staff of several scientists, including Mr. P. G. Law, the *Wyatt Earp*, manned by a naval crew under the command of Commander Karl Oom, made a short, late-season cruise into the pack-ice, including a visit to the Balleney Islands.

The report furnished at the conclusion of the cruise indicated that the *Wyatt Earp* was too small for the undertakings planned, her capacity being barely sufficient for the naval crew, leaving insufficient accommodation for the transport of shore-station staff and their equipment. The antarctic section of the programme was then suspended until a suitable vessel of greater capacity should be made available. The sub-antarctic stations, which were at that time being serviced annually by a naval L.S.T. vessel, were in the meantime to continue in operation.

Group-Captain Campbell returned to his post-war assignment in Commonwealth Civil Aviation Controls, and for several years since has been on duty in Siam as Commonwealth officer on loan to help reorganize civil aviation in that country.

In the meantime, the Department of External Affairs established an Antarctic Division to take care of Australian activities in the Far South. Mr. P. G. Law is the officer in charge.

The stations at Macquarie Island and at Heard Island have continued to function without a break, the personnel being relieved each year by the transport of new staff and supplies. The meteorological programme has been specially stressed, since it is hoped that by a detailed study of the movements of air masses between Antarctica and Australia the possibility of forecasting the weather of southern Australia may be enhanced.

Considerable attention is being given to geophysics, radiophysics and cosmic ray studies, and there is ample provision for cartographical, biological and geological activities. Already there has been amassed a very substantial and valuable addition to knowledge of the sub-antarctic in the Australian region.

What is now due to be undertaken is the extension of this programme to the antarctic mainland. This depends upon the provision of adequate transport. The design of a vessel especially to meet the needs of exploration within the pack-ice zone was submitted through the Navy Department, but, on account of cost, has been shelved. Nevertheless, provision has now been made for the establishment next summer of a base station on the antarctic mainland. Final approval and an outline of plans was recently notified by the Right Hon. R. G. Casey, Minister of External Affairs.

A Danish vessel, the *Kista Dan*, designed for navigation in the Greenland seas, has been chartered as a transport. As this vessel has also to relieve the Heard Island staff during the same antarctic cruise, the party to be established on the mainland will comprise not more than nine or ten men.

This antarctic mainland party will undertake during 1954 reconnaissance operations preparatory, it is hoped, to more extended developments in succeeding years. Scientific operations during the first year of occupation will be concerned mainly with geographical land exploration, geology and meteorology.

It is anticipated that the shore station will be established on the MacRobertson Land coast, where several suitable sites are known. Two Auster aircraft will be taken on the *Kista Dan*. Shore operations will be undertaken with the aid of mechanical transport, 'weesels' and with dog-drawn sledges. The sledge dogs have been under training at Heard Island.

Robert G. Dovers, a son of George Dovers of the Queen Mary Land party of the Australasian Antarctic Expedition of 1911–14, is to be leader. For the work ahead he has already had good experience, as he was cartographer to the Heard Island party of occupation during 1948 and continued thereafter an active member of the expedition staff. Dovers, as observing officer for A.N.A.R.E. at the invitation of the commander of the French expedition, spent the year 1952 in Adelie Land gaining first-hand information in sledging operations.

Attached to Dovers's party during 1954 will be a French representative as observer.

The Planning Committee expects to extend greatly the scientific programme of the mainland station during subsequent years. Ice-cap seismic-sounding will then receive special attention.

OBITUARIES

Dr. W. A. R. Dillon-Weston

William Alastair Royal Dillon-Weston, chief plant pathologist in the eastern province of the National Agricultural Advisory Service, died in Cambridge on August 20, at the age of fifty-four. A West Countryman by birth, he was educated at Bristol Grammar School and St. Catherine's College, Cambridge, where, after gaining honours in Part I of the Natural Sciences Tripos, he took a diploma in agriculture in 1922. Shortly afterwards he was appointed by the University as one of the provincial advisory mycologists to the Ministry of Agriculture and Fisheries, stationed at the School of Agriculture, Cambridge. His subsequent working life of nearly thirty years was spent in serving the farming community of East Anglia, for although he left the University for the National Agricultural Advisory Service when it was established in 1946, his duties remained unchanged and his new station was but two miles from his old one. He took his M.A. in 1925 and a Ph.D. in 1929.

Dillon-Weston was a sensitive artist, full of stimulating and occasionally unusual ideas, kindly disposed to others, hospitable, and always ready to give a helping hand. Yet his restless impetuosity and sense of the dramatic, together with a tendency to brook no interference with his affairs, at times induced exasperation even among those who knew and admired him most. This conflict of qualities was reflected in his work and in his wide and changing interests. He combined research and advice in a manner that enhanced the value of both, and published nearly one hundred scientific and semi-popular articles on mycology and plant diseases, half of which were concerned with diseases of cereals and fungicidal treatment of cereal and other seeds. His early research was carried out on fruit tree diseases, notably apple scab; but he became increasingly interested in the rusts and smuts of cereals, particularly following on an exchange of posts for twelve months during 1930–31 with Dr. Craigie of the Dominion Rust Research Laboratory in Winnipeg. Shortly after his return from Canada he and Dr. J. R. Booer began an intensive study of the fungicidal action of mercury compounds. As a result of this and subsequent work, Dillon-Weston's name will long be linked with the advances made in fungicidal seed treatment in Britain. But he also investigated diseases of potato, sugar beet, clover, beans and other crops that came to his notice during his advisory work. He was interested in the theoretical as well as the strictly practical side, and his contributions ranged from the effect of ultra-violet radiation on fungus spores to the significance of 'black spot' in eggs.

His spare-time hobbies were many and varied, but mycology crept into most of them. When an enthusiastic airman, he studied the fungus flora of the upper air; later, as an expert glass-blower, he made many beautiful glass models of fungi; and as an artist he painted plant diseases, designed posters and film strips, directed films on potato blight and cereal seed disinfection and, with Ann Murray's assistance, issued pictorial life-cycles for many pathogenic fungi. In 1948 he published three popular booklets on diseases of farm and vegetable crops, and his book "The Plant in Health and Disease", written in conjunction with Dr. R. E. Taylor, appeared the same year. He was married and is survived by a widow and two children. W. C. Moore

Mr. T. Raymont

The death, in his eighty-ninth year, of Thomas Raymont removes one of the last survivors of that group of pioneers who at the turn of the century were establishing a livelier and more liberal conception of the training of teachers, in association—precarious at first—with the newer universities. Others among them were John Adams, and later Percy Nunn, at the London Day Training College, and J. W. Adamson at King's College in London, J. J. Findlay in Manchester, James Welton in Leeds and Mark Wright in Newcastle.

The greater part of Raymont's working life was concerned with teacher training, first for fifteen years as professor of education at Cardiff, and then for twenty-two years at Goldsmiths' College in New Cross, London. As vice-principal on the men's side and later as warden of the College, he had much to do with the development of that anomalous and adventurous institution, in which the so-called Day Training Department was advantageously part of a larger whole. Among his achievements was the establishment of general degree courses in arts and science for a proportion (about one-fifth) of the students in the Training Department, a number of members of the College staff being 'recognized teachers' of the University of London.

During his last year at Goldsmiths', he enjoyed the opportunity of a visit to America. When he relinquished the wardenship in 1927, he continued for a further eight years to act as educational adviser to the National Froebel Union and was chairman until 1937; he had been a governor of the Union for thirty years.

Raymont took a leading part in the emancipation of training colleges from the dead hand of nineteenth-century traditions, and was influential in the counsels of his colleagues. He was president of the Training College Association in 1928. He continued to the end to take an active interest in the Old Students' Association of Goldsmiths' College and was, as always, held in high esteem and affectionate remembrance by some thousands of his old students, both in London and in Cardiff.

His writings extended his influence, notably his "Principles of Education" (1904) and "The Use of the Bible in Education" (1911), both of which were widely used in their time. His later book, "Education" (1931), was a broad and mature survey of the field at large, steadily and as a whole, the wood rather than the trees.

Failing eyesight eventually led him to withdraw from London life to relative seclusion at St. Ives, but he continued to write book reviews in educational periodicals and until a few years ago he was a frequent contributor to *Nature*.

At the end of his long and fruitful life, it is fitting that Thomas Raymont's place should be recognized among the pioneers in educational expansion after the Act of 1902, and in particular in the liberalization of teacher training. A. E. DEAN

Prof. S. Parker Smith, C.B.E.

THE genius of Stanley Parker Smith, who died suddenly at Perth on August 21, in his seventieth year, had two distinctly contrasting aspects: that of the practical electrical engineer and latterly that of the teacher and educationist.

During the earlier years of his career, his activities as designer of dynamo-electric machinery, particularly of large turbo-alternators and machines for special applications, earned for him a wide reputation. That he was invariably successful in his designs, particularly at a time of rapid expansion in the size of the units and in the complication of electric generating plant and motive power, can be attributed to a combination of knowledge, scientific and practical. This combination gave him almost complete self-confidence in technical matters. It was not unjustified. He once told me that, when his final revision of the design schedule for one of the largest turbo-alternators that had hitherto been made was finished, he was no longer particularly interested in it but turned his thoughts to another problem. When figures came through from the test-house, they showed a performance which was more often than otherwise an improvement upon the predictions upon which his firm's guarantee had been based.

Tenacity of purpose and singleness of aim were among Prof. Parker Smith's outstanding characteristics. His only hobby was his work. These attributes, in combination with exceptional academic ability, won for him a scholarship which took him from Grantham Grammar School to Armstrong College, Newcastle upon Tyne. He graduated B.Sc. in the University of Durham, with special distinction in electrical engineering. He was awarded in 1905 an 1851 Royal Exhibition research fellowship. This enabled him to complete his technical education at the Technische Hochschule in Karlsruhe, where he specialized in the study of dynamo-electric machine design under Dr. Arnold, who was possibly the outstanding authority on this subject. He was later awarded, by the University of Durham, the degree of M.Sc., which was followed by that of D.Sc. His most important contribution to this branch of science was his paper on the "Theory of Armature Windings" before the Institution of Electrical Engineers. This piece of work reflected the results of these years of intensive application. He is also represented by other papers, either wholly or in part authorship, on electric generators. He was also interested in electric traction, and a paper concerned with the calculation of the starting resistances for traction series motors was awarded a premium by the Institution of Electrical Engineers. About this time, a journey of investigation into Swiss and German practice was made and the results published.

After filling the positions of assistant designer with Siemens of Stafford (1907) and chief designer with the General Electric Co. (1909), in 1912 he accepted the post of lecturer in electrical design at the City and Guilds (Engineering) College of the Imperial College of Science and Technology, London, and afterwards became an assistant professor. He was appointed in 1923 professor of electrical engineering in the Royal Technical College, Glasgow, in succession to Prof. Magnus Maclean, who was the first holder of that title there. He resigned the chair in 1948 to become the organizer of the Staff College of the North of Scotland Hydro-Electric Board at Pitlochry in Perthshire.

During the time he occupied the chair in Glasgow, the Institution of Electrical Engineers accepted papers from him dealing with the cathode-ray oscillograph and with the domestic applications of electricity, and there were published the following text-books, which have continued into several editions: "Problems in Electrical Engineering", "The Electrical Equipment of Automobiles", electrical laboratory manuals on measurements and on machines, and an electrical engineering design-class manual.

As regards his record as teacher and educationist it may be recalled that four of his former students are now professors of electrical engineering, and the modernized teaching laboratories of the Electrical Engineering Department of the Royal Technical College at Glasgow also are witness to his work.

Prof. Parker Smith was always keenly interested in the activities and the well-being of the Institution of Electrical Engineers. He gave much time in helping to co-ordinate the functions of the Ministry of Education, the Scottish Education Department, and the Institution in bringing about the efficient and smooth working of the schemes for national certificates and diplomas. He had served as a member of council of the Institution and, in 1941, as vice-president. He was chairman of the Scottish Centre during 1939–41.

At the end of the Second World War, he received the award of C.B.E., in recognition of his services in connexion with the technical training of recruits to the Army, Navy and the Air Force at the Royal Technical College.

Prof. Parker Smith is survived by his widow, a son and a daughter. F. E. MEADE

TO SIR EDWARD APPLETON

On hearing his Presidential Address to the British Association, 1953

Within the hush'd and crowded hall, now gay
With learning's silken panoplied array,
We sit enrapt; companion'd, warm, secure
In a familiar world, serene, demure;
Our minds elsewhere, above the veil of night
Borne on imagination's thrusting flight
Through the unending, roofless vaults of space
Where galaxies pursue their timeless race
In distant majesty; about them spread
A seeming frozen silence, deathless, dead.

Did we possess your magic, we might hear
The voiceless ether murm'ring low and clear
A myriad soft whispers, mystic tone
Of outer worlds, the known and yet unknown.
How wise the mind that thus can apprehend
A universe too vast to have an end,
The ear its ghostly note detect, the hand
A new strange music of the spheres command.

Stanley Dumbell*

NEWS and VIEWS

British Association:

President for 1954: Dr. E. D. Adrian, O.M., F.R.S.

Dr. E. D. Adrian has been elected president of the British Association for 1954 and will therefore preside over next year's annual meeting at Oxford. Dr. Adrian has been president of the Royal Society since 1950. His work, which has had such a profound effect on the biological sciences, was reviewed in *Nature* on his election as president of the Royal Society (*Nature*, 166, 978; 1950). Much of his scientific research was carried out while he was Foulerton professor of the Royal Society during 1929–37 and later professor of physiology in the University of Cambridge during 1937–51. He holds the Baly Medal of the Royal College of Physicians, a Royal and the Copley Medals of the Royal Society and the Gold Medal of the Royal Society of Medicine. In 1932 he was awarded the Nobel Prize for Medicine, and in 1942 he received the Order of Merit. Since 1951, Dr. Adrian has been Master of Trinity College, Cambridge.

Downe House

Downe House, Kent, the national memorial to Charles Darwin, where for forty years Darwin lived and where he wrote his "Origin of Species", has been transferred from the custody of the British Association to that of the Royal College of Surgeons.

Technology and Professional Work

Some points raised by Lieut-Colonel S. M. K. Mallick's address, "Medicine—a Technology or a Profession", at the plenary session on August 24 of the First World Conference on Medical Education are of interest in the wider context of current discussion in Great Britain on higher technological education generally. Accepting the definition of a profession as implying an occupation in which one professes to be skilled and which one adopts as a means of living, Col. Mallick thought that there are still good reasons for restricting the word 'profession' to the three vocations of divinity, law and medicine. He defined technology as a systematized or scientific study of the practical or industrial arts, while medicine he claimed is a specialized knowledge the practice of which is concerned with disease and the advancement of health. Despite this rather controversial restriction of the term 'profession' and his failure to probe deeply enough into the meaning of technology, which he does not distinguish at all clearly from a technique, Col. Mallick's concern that through the mass-production of immature specialists, aided by socialization, the profession may be converted into a technology and the medical man become merely a high-class technician, has implications for the planning of higher technological education and especially for those who insist on the importance of an adequate basis of general education. The danger in medicine is that the specialized studies which are so readily encouraged by current tendencies will swamp the basic general education that a university discipline, such as medical education, is calculated to impart. A system which is more than vocational training must have a relevance to life in general, and though technical education is an indispensable foundation, education in the sense of the development of the power to form judgments becomes possible only after techniques have been mastered. Col. Mallick believes that the danger in medicine would be averted by the revival of the general physician and the general surgeon on better-organized lines, and by recognizing the difference between profession and technology and re-establishing the pre-eminence of the professional aspect and tradition.

Science and Productivity in Britain

In a debate on science and productivity in the House of Commons on July 20, the Parliamentary Secretary to the House of Commons, Mr. Hugh Molson, referring to the recommendation in the sixth report of the Advisory Council for Scientific Policy regarding the increased use of development contracts, said that the Ministry of Fuel and Power has already granted contracts for developing gas turbines run on peat and on coal, while several contracts have been granted for developing the large heat pump made for heating and cooling the Royal Festival Hall. Mr. Molson said that the Department of Scientific and Industrial Research is also exploring the practicability of development through the research associations, and referred to collaboration between the Road Research Laboratory, the British Road Tar Association and the North Thames Gas Board in the

* Registrar, University of Liverpool, and Joint Local Hon. Secretary of the British Association Meeting at Liverpool, 1953.

preparation of a special type of tar for road-surfacing, and between the Building Research Station and the British Electricity Authority in developing the manufacture of bricks from the ash of power stations. Mr. Molson also reaffirmed the Government's intention to build a science centre in London and said that the site on the South Bank is still reserved for the purpose.

Little else of fresh interest emerged in the debate. Sir William Darling pointed out that the most effective industrial research organizations are created by industrial firms themselves, and there is some general recognition of the dangers of relying on a government organization, even of the type of the National Research Development Corporation, for development work; there is also the vital importance of good industrial relations in securing the effective co-operation on which efficient production depends. Equally, he added, it is recognized that the practice of indiscriminately denigrating business enterprise and management is not conducive to good relations and co-operation. Mr. A. Allen made a point that is now exercising men of science when he referred to the other arduous duties of the Lord President of the Council and urged that there should be a senior minister giving undivided attention to the scientific responsibilities and interests of the Lord President. Mr. W. Shepherd pressed for greater use of consultants in industry.

Education and the Oil Industry

THE world demand for the products of petroleum has more than doubled over the past fifteen years. It may well double again in the next fifteen years and, if so, there will be need for an increasing number of men who, by combining ability, technical knowledge and experience, can fill administrative posts of all kinds. The petroleum industry was among the first to seek the help of the universities in meeting its need for technical and administrative staff, in promoting academic studies in the applied sciences and in furthering education and training within its own organization. This has been particularly true of the Shell Organization which, with its associates in the Royal Dutch/Shell Group of oil companies, to-day operates in more than fifteen countries and employs a quarter of a million persons ("Venture in Education". Pp. 8. London: Shell Petroleum Co., Ltd., 1953). The Organization is faced with many educational problems in many lands and its general policy has had to be adapted not only to the industry but also to the community it serves. For a long time the universities have been looked to for men qualified for the technical side of the business. It has also been realized that the intellectual discipline of university training was no less valuable on the commercial and administrative sides than on the technical, and in particular that the Group's overseas marketing organization offered scope and opportunity to the arts graduate. A record of the activities of the Shell Group has been set down in a publication called "Venture in Education", which also indicates the financial support which the Organization has given to the universities. So long ago as 1912, for example, a donation was made to the University of Cambridge for a readership in physical chemistry, and this was followed in 1919 by a gift of £50,000 towards the establishment at Cambridge of the physical chemistry laboratory. Recent donations have totalled well over half a million pounds, while each year the Organization is spending a total of approximately £275,000 on its own educational activities.

City and Guilds of London Institute

ON the threshold of its seventy-fifth anniversary, the City and Guilds of London Institute finds itself in a critical and challenging position (City and Guilds of London Institute. Report of the Council for the Year 1952. Pp. 52. London: City and Guilds of London Institute, 1953). There is little doubt that the national importance of its work in technical education is appreciated, as is shown by the continued call for its syllabuses in established and new industrial fields and for its advisory services in educational matters of a more general and far-reaching nature. The critical point has been reached because the available resources of the City of London Corporation and Livery Companies can no longer maintain, let alone expand, the work of the Institute. The problem of accommodation for the Department of Technology is seriously hampering its work; suitable accommodation conveniently located and on one site would ease administration and lead to appreciable economies. In view of the increasing amount of work of the Department of Technology, this is a matter which is causing grave concern to the Council of the Institute. Since the War, the number of candidates taking examinations under the ægis of the Department of Technology has more than doubled. There have also been sixty-five major revisions, and thirty-one completely new subjects have been introduced. These figures are all the more impressive when it is realized that in many cases a subject may, in fact, include two or three independent schemes of syllabuses and related examinations. The need to balance claims of the development of a large number of new projects against the revision of existing subjects is a constant problem for the Department of Technology. At present, twenty subjects are being scrutinized and will shortly be completely revised. At the same time, many new subjects are in preparation.

Impact of Industry on the Worker

IN an imaginative but well-authenticated article, Nigel Balchin, the well-known psychologist and author, examines the way in which the growth of industry has affected the outlook and philosophy of those who work in large or small industrial undertakings (*J. Inst. Personnel Management*, June 1953). A comparison is made between the life of the agricultural worker and of the individual whose working life is confined to the factory, and Balchin concludes that the impact of industry upon the worker has been to destroy the simple and direct significance of work done and hence to sever the mental link between 'work' and life. In these circumstances 'work' is liable to become something which has no logic or point in itself. The impact of the huge and complicated industry structure on the worker has been to confuse the mind as to his real desires and requirements and to leave him with a vague impression that man exists for industry rather than *vice versa*.

Cambridge University Educational Film Council

THE sixth report of the Cambridge University Educational Film Council contains a description of experiments which have been made in the use of films for teaching history (Cambridge University Educational Film Council. Sixth Report, March 1953. Pp. 8. Cambridge, 1953). In collaboration with the Cambridge Branch of the Historical Association, a series of feature films have been shown to

complement 'outline courses' in medieval and modern history of the Faculty of History. The films shown included "Alexander Nevsky", "Der Alte und Junge Kŏnig" and "M. Vincent". In collaboration with the same Association the Film Council also arranged a film demonstration at which the films "Stone Age Tools", "Paridiso Perduto", "Transfer of Power", and "Edwardian Newsreel" were shown. Film sessions have also been arranged for students of economics, Slavonic studies, archæology, anthropology, geography, engineering and zoology. Considerable use of films is made in the Department of Anatomy, where films for teaching purposes have been made. A useful teaching film showing stream erosion in a laboratory model has been completed in the Department of Geography. The use of cinematography in research continues in a number of university departments, including those of engineering, geography, geodesy and geophysics, and experimental psychology. In the Department of Anatomy, films showing the growth of nerve fibres and the reaction of chemotherapeutic compounds on living cells have been made; in the Cavendish Laboratory a new version of the bubble model film has been prepared.

Three-Dimensional Films

It is curious that the widespread interest in three-dimensional films should have been stimulated by the appearance of a two-dimensional panoramic system—'Cinerama'—followed closely by the announcement of a similar system yet to come—'Cinemascope'. Although both are spectacular, neither method is truly stereoscopic, the specious illusion of some depth attained being dependent upon wide-angle peripheral vision and upon the slightly different images seen by each eye, both effects being conferred by a curved screen. Other older systems which rely upon a truly three-dimensional presentation have benefited by this publicity in being brought more into public awareness. Before a film can be called '3-*D*' it must be truly stereoscopic. For this, it is essential that each of the viewing eyes shall receive a dissimilar picture from the other—the so-called 'disparate' images that are seen in real life by two separated eyes. In consequence, whatever the methods of projecting pictures upon the screen may be, it is essential that there should be differentiation as between the two eyes, either at the eyes or at the screen. Systems using the first of these methods, where the required discrimination takes place at the eyes, are at the moment more successful and are commercially therefore more important. The possibilities of three-dimensional films are discussed by H. Dewhirst in a recent issue of *Science and Film*.

Limits of the Oceans and Seas

The third edition of "Limits of Oceans and Seas" has been published by the International Hydrographic Bureau, Monte Carlo (pp. 38; 1953; n.p.), and consists of thirty-eight pages of text and three large diagrams, giving the position and extent of the seas. The limits as described in the text and shown in the diagrams are solely for the convenience of national hydrographic offices in compiling notices to mariners and for other practical reasons; they have no relation to physical considerations and, of course, are of no political significance. The Antarctic, or Southern Ocean, is now omitted on the plea that this body of water has no well-defined limits to the north, but rather a seasonal variation. The southern limits of the other oceans are therefore extended to the Antarctic continent, and the various Antarctic seas, such as Ross, Weddell and Bellingshausen, are omitted. Straits joining two seas have been allotted to one of them. Meridians, parallels and rhumb lines have been used so far as possible for the limits of seas. The extent of the great oceans, including the Arctic Ocean, excludes the seas lying within each of them, this being mainly for practical purposes.

Men of the Trees

The summer issue of the journal of the Society of the Men of the Trees contains an account by Mr. Richard St. Barbe Baker of the expedition which he led last year to survey desert areas in Africa and to advise on means of combating erosion by afforestation (**17**, No. 1). To publicize and finance the "green front campaign against the desert", stamps have been produced showing a 'lone tree' in the middle of the Sahara. This tree stands six hundred miles from others in the middle of the desert, although the forest which was once there had disappeared because of drought or had been obliterated by sand storms. With the money collected from the sale of the stamps it is hoped to complete the desert survey and to purchase tree seeds and start tree nurseries in positions where they are most urgently needed. The journal also contains articles on the New Forest by J. Brambell Hill, the Worcester Beacon by E. R. Gordon, Cranford Park by A. Leonard Summers, the third in a series of articles on the biological task of forestry by Henry Baldwin, and a fine lyrical poem on elms by Leonora Lockhart.

Mutagenic Possibilities of Phosphorus-32

The occurrence and utility of bud sports in fruit trees have been discussed by W. R. Stanton and W. K. Sinclair (*J. Exp. Bot.*, **4**, 10, 78; 1953) and the merits of various mutagenic agents compared. These authors suggest that phosphorus-32 may prove a suitable mutagen in the production of fruit-tree mutations. In particular, experiments are described on the uptake and distribution of phosphorus-32 by plums. It is shown that the concentration of phosphorus-32 in buds may reach a level at which mutagenic effects are likely to be induced, but that at such concentrations there is little evidence of macroscopic injury. The method which is described —based on the culture of young trees in sand plus nutrients—appears to be suitable for fruit trees.

Micro-organisms maintained in Australian Institutes

The Commonwealth Scientific and Industrial Research Organization of Australia has issued a booklet entitled "Directory and Catalogue of Micro-organisms maintained in Australia", which lists the micro-organisms held as type cultures in the biological institutes of Australia (pp. 74; Melbourne: C.S.I.R.O., 1952). This work has been done to implement a recommendation of the British Commonwealth specialist conference on culture collections of micro-organisms, which was held in London during August 1947, that a directory of important culture collections in the Commonwealth should be prepared. At present there is no centralized collection in Australia. The Australian "Directory" embodies information submitted by forty-two institutions and lists several hundred species of bacteria and fungi, some seven species of protozoa, some fifty strains of yeasts, fifty-seven strains of bacteriophages, and twenty-nine strains of viruses. The strains are classified into

those authenticated by other national collections of type cultures, or by Australian specialists, and those cultures the authenticity of which cannot be guaranteed. The "Directory" should admirably fulfil its function of informing scientific workers in Australia and in neighbouring countries of the biological material that is readily available to them, and of advertising to men of science elsewhere the extent of Australian collections.

Kodaikanal Observatory during the Past Fifty Years

A SURVEY of the work of the Kodaikanal Observatory during the past fifty years, from the days of Prof. C. Michie Smith, the first director, up to the present time, is contained in a small booklet entitled "Kodaikanal Observatory 1901–51", issued by the Indian Meteorological Office (pp. 44+12 plates. Delhi: Manager of Publications, 1952; 1 rupee). A considerable amount of the publication is devoted to an account of the work of Evershed, who became director in 1911 after four years as assistant director, and of Royds, who joined as assistant director in the year in which Evershed became director. It is pointed out that the period of sixteen years that Evershed spent at Kodaikanal was marked by great activity, and his and Royds's researches during this time brought Kodaikanal to the front rank among astrophysical observatories. Besides a brief historical outline of the establishment and development of the Solar Physics Observatory at Kodaikanal in 1899, which was derived from the Madras Observatory started in 1792 by the East India Company, the publication describes the instrumental equipment and observational work carried out by the sixteen instruments and five different spectrographs. The account of the work includes sections on the following subjects, among others: discovery of radial motion in sunspots; memoirs on sunspot spectra and prominences; sun-arc displacements—pressure in the reversing layer; Venus spectra; spectroscopic studies; studies on sunspots and prominences; study of Hα dark markings; and prominences and radiation pressure. Supplies of photoheliograms have been sent to the Royal Greenwich Observatory almost from the beginning, and since 1906 exchanges of spectroheliograms have been made with the Solar Physics Observatory, Cambridge. Future developments depend on the financial aid which can be obtained, as contributions in practical and observational work are handicapped from lack of instrumental equipment. As one instance, a really large solar spectrograph with an adequately powerful cœlostat and other accessories, and a Lyot coronagraph are badly needed. Although the Government of India appointed a Standing Advisory Board for Astronomy and Astrophysics in 1948, and a meeting was held in April 1949 as a result of which recommendations were made to the Government, very little had been done up to the time of writing. It is to be hoped that the present director, Dr. A. K. Das, will be able to secure the necessary funds to maintain and even enhance the excellent reputation of this Observatory. Just of late a few items have received attention, and it is very satisfactory to know that the ionospheric laboratory has been completed and the ionosphere recorder installed.

Memoirs of the Society for Endocrinology

THE Society for Endocrinology is proposing to publish a series of memoirs recording the proceedings of conferences on endocrinological subjects. The first memoir, on the thyroid gland, has recently appeared and contains papers read at a conference held in London on February 25, which was organized by the Society jointly with the Endocrinological Section of the Royal Society of Medicine (pp. 48+4 plates; 3*s*. to members, 5*s*. to non-members). The second, which reports a recent conference on the determination of adrenocortical steroids and their metabolites, is in the course of preparation and will be ready shortly. By means of this new venture the Society hopes to effect speedy publication in convenient form, and at a low cost, of papers on topics undergoing rapid change, and, to this end, typolith printing has been used in spite of its æsthetic shortcomings. That the Society has been successful in its main object of rapid publication is apparent from the fact that the memoir on the thyroid gland has appeared only four months after the conference, a notable achievement under present conditions. The memoirs can be obtained by non-members of the Society through any bookseller or direct from Pitmans Press, Parker Street, London, W.C.2.

Medical Research Council: New Members

BY an Order of the Committee of Privy Council for Medical Research, made after consultation with the Medical Research Council and with the president of the Royal Society, Prof. Robert Platt, professor of medicine in the University of Manchester, and Prof. Edward T. C. Spooner, professor of bacteriology and immunology in the London School of Hygiene and Tropical Medicine, have been appointed to be members of the Medical Research Council as from October 1, 1953.

Welded Steel Structures

A JOINT committee appointed by the Ministry of Works, the Institution of Civil Engineers and the Institution of Structural Engineers, with the support of the Admiralty, War Office, Ministry of Supply, Ministry of Transport and Department of Scientific and Industrial Research, is organizing a conference, the purpose of which is to review present knowledge and outstanding problems in the design, fabrication and erection of welded steel structures. The conference will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, during November 23–27. Eleven topics have been chosen for discussion, for each of which a special review paper has been prepared; the papers will be circulated beforehand so that most of the time at the conference can be used for discussion. The conference is open to all interested in the subject. Application forms for membership and all further information can be obtained from the Joint Honorary Secretaries, Conference on Welded Structures, Institution of Civil Engineers, Great George Street, London, S.W.1.

Shell Petroleum Co. Awards

POSTGRADUATE scholarship awards have been made by the Shell Petroleum Co., Ltd., to the following overseas students to enable them to work in British universities: E. A. Parkes, of the University of Tasmania (London), and A. D. Buckingham, of the University of Sydney (Cambridge); M. H. Panckhurst, of Canterbury University College, N.Z. (Oxford), and J. H. Percy, of Auckland University College (Cambridge); M. J. Stephen, of the University of the Witwatersrand (Oxford), and W. A. Little, of Rhodes University College (Glasgow).

STRUCTURE OF THE ATOMIC NUCLEUS

ABOUT three hundred nuclear physicists, a hundred and twenty of them from overseas, met at the University of Birmingham during July 13–18 for discussions on nuclear structure. At each session, an opening speaker surveyed some portion of the field: his introduction was followed by contributions from those who had new information or who took other points of view. Much of the value of such a conference lies in the debating of divergent opinions or apparently contradictory experimental facts, but a report after the style of *Hansard* is not possible. The following account, covering only a few of the topics actually discussed, is intended to pick out some of the points of liveliest interest.

In several of the sessions the question of nuclear models was raised. In particular, this referred to the suitability of the 'shell model', as opposed to the 'liquid drop' model. The first treats the nucleus, as is usual in the case of the atom, as an assembly of individual particles, moving independently in a common field of force. For the past few years considerable success has been obtained from the use of this model, provided one assumes that there exists for each particle a strong interaction between its spin and its orbital angular momentum. B. H. Flowers (Harwell) summed up this picture in one of the opening talks and showed that, by making use of the correct alignment of the orbits of different particles when there is more than one particle outside a closed shell, one can account for the behaviour of magnetic moments and quadrupole moments in cases which had previously presented difficulty. Many other successes of the shell model, relating also to nuclear reactions, were referred to in the discussion.

On the other hand, it was stressed by A. Bohr (Copenhagen) that an approach starting from a collective motion of many particles also finds a good deal of support from direct evidence. He assumes that the potential field acting on all the particles has a fairly sharply defined surface which may alter its shape as a result of the motion of the particles, and which therefore represents a set of degrees of freedom of the system. Since this surface is coupled with the motion of each particle inside it, it provides an indirect means of connecting the motion of different particles.

One particular piece of evidence favouring this 'liquid drop' model is the existence of 'rotational' states in certain nuclei. To take the simplest case, an even–even nucleus with angular momentum zero in its ground-state, often is found to have excited states of angular momenta 2, 4 . . ., the energy of excitation being proportional to $J(J + 1)$, where J is the angular momentum. The factor of proportionality defines an effective moment of inertia, and this is found to be much larger than that for a single nucleon in an orbit the size of a nucleus, but much smaller than that for the whole nucleus considered as a rigid body. According to the Bohr theory, these states are to be understood not as a rotation of the nucleus as a whole but as an irrotational mode of motion in which the shape of the external surface revolves about its centre. As this model predicts, the transitions between such levels are associated with very large electric quadrupole moments which would not easily be explained in other ways. T. Huus (Copenhagen) described recently published experiments in which excited states, interpreted as rotational levels, are produced by the electric field of protons passing close to nuclei but not actually colliding.

In one sense the liquid drop model is a different extreme to the shell model, and the use of these different pictures in itself does not necessarily constitute a contradiction. In particular, the liquid drop model does not allow for the peculiar features arising from the closing of shells and should be most satisfactory well away from the closed-shell nuclei (magic numbers), whereas the shell model becomes prohibitively complicated in that region and allows the most precise predictions near the closed shells.

However, differences of opinion arise when one has to decide which of the two pictures is appropriate in any particular problem, and such points led to a lively discussion. The questions were not, of course, finally resolved, but the discussions gave all participants a rather clearer idea of the unsolved problems.

Another question about models which figured prominently in the discussion was the proper description for a nucleus in interaction with a fast neutron or proton. H. H. Barschall (Wisconsin) reported very extensive and interesting results about the scattering of neutrons in many nuclei, both as regards energy dependence and angular distribution, and this seems to agree remarkably well with a model proposed by Weisskopf in which the nucleus is treated as a sphere with a constant refractive index and absorption coefficient—a 'clouded crystal ball'—though the absorption coefficient used to fit the curves is surprisingly small.

Several different methods of estimating the radius of a nucleus were mentioned, the most extensive work being reported by R. Hofstadter (Stanford) on the scattering of 150-MeV. electrons by nuclei. These curves are interpreted directly as diffraction patterns. They would indicate an electric density distribution in the nucleus with a fairly strong maximum in the middle and a gradual decay rather than the usual picture of a uniform density with a sharply defined boundary. However, the distortion of the electron wave function by the electric field of the nucleus is large enough to throw doubt on the simple diffraction theory, and more work will have to be done to be sure of the interpretation of the experiments. The energy difference between the $2p$- and $1s$-levels of μ-mesons near a nucleus also tends to indicate that the generally accepted formula for the nuclear radius may not be reliable.

In considering most nuclear processes, it is proper to think of a nucleus as an isolated system, but one session of the conference centred around instances where the surrounding electrons, or even neighbouring atoms, are of major importance. Conversion of nuclear excitation energy through interaction with the atomic K, L, M . . . shells is a stock example; so also is the capture of an orbital electron by a nucleus. In addition to these, there were discussions of the directional correlations of successive radiations from a single atom. The anisotropy of the second radiation with respect to the direction of the first may be upset by a change of orientation of the nucleus while in the intermediate state. E. Heer (Zurich) described the effect of an external magnetic field on correlation between successive transitions in cadmium-111 (the product of the β-decay of indium-111), from which the magnetic moment of the first excited state could be deduced. The anisotropy in

the absence of an external field depends upon the crystalline state of the source; for a polycrystalline indium source, it shows a maximum value of 20 per cent at the melting point. Experiments with single (non-cubic) crystals showed a dependence of the observed anisotropy upon the orientation of the counters with respect to the crystal axes.

Other topics involving atomic processes were the elastic scattering of gamma-rays, in which scattering by bound electrons is coherent with nuclear scattering and the orientation of radioactive nuclei by magnetic fields at low temperatures, which has been achieved with elements that form Tutton salts.

In sessions devoted to experimental techniques, reports were given by D. Walker and J. H. Fremlin (Birmingham) of the processes by which multiply-charged ions (for example, $^{14}N^{6+}$) can be accelerated in a cyclotron and of the types of nuclear reaction that such relatively heavy nuclei produce. Particular interest was shown in an impromptu description given by R. Birge (Berkeley) of the bubble-chamber experiments initiated by Glaser at Michigan, in which ionizing particles cause ebullition in a superheated liquid.

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY

THE Second International Congress on Rheology was held in Oxford during July 26–31 and was attended by some 245 rheologists accompanied by about fifty visitors. The proceedings commenced with an address on "Rheology for Mathematicians", given by the president of the Congress, Sir Geoffrey Taylor, who discussed various way in which mathematicians can help rheologists and the attitude of practical rheologists to the pure mathematician.

The technical programme of the Congress consisted of six invited lectures as well as a number of sectional meetings run in parallel. Nearly half of the forty-nine contributed papers dealt with properties of high polymers, and these provided the subject-matter for Section *A* for the whole of the Congress. A short (half-day) Section *C* was concerned with problems of lubrication, all other contributions being grouped into a miscellaneous Section *B*.

In drawing up the programme, the aim of the organizing committee had been to cover the extended field of "the study of the deformation and flow of matter" as widely as possible. The subjects of the invited lectures illustrate this policy: sur l'effet éléctrovisqueux (Mme. A. Dobry-Duclaux, Paris); rheological problems in the fabrication of plastics (Dr. R. S. Spencer, Midland, Mich.); rheology and applied mechanics (Dr. R. N. J. Saal, Amsterdam); rheological behaviour and the molecular jumping mechanism (Prof. F. H. Müller, Marburg); water association and hydrogels (Mr. E. Forslind, Stockholm); and biological problems for the rheologist (Dr. P. Eggleton, Edinburgh). As well as many papers on plastics and high polymers generally, sectional papers covered a wide range of materials—for example, clays, metals, gelatine gels, flour doughs, diamonds, greases, bitumens and protoplasm. Discussions ranged from methods of viscometry to the study of chronic bronchitis in man and the diagnosis of pregnancy in the cow. Papers were read, and discussions took place, in English, French and German.

Most of the papers were circulated as preprints before the meeting opened; all of them, together with summaries of the discussions which followed, will be published in book form by Butterworth's Publications, Ltd., London, and will appear, it is hoped, within about six months. In conjunction with the Congress there was a small exhibition of commercially available rheological apparatus, and an Oxford bookseller also arranged a special display of rheological books.

There were three evening meetings. At the first of these, a number of technical films was shown, including one illustrating Sir Geoffrey Taylor's own investigations on the dragging of anchors. Another evening was devoted to a discussion on international organization of rheology, at which the International Union of Pure and Applied Physics was represented by its president, Prof. N. F. Mott (Bristol), the International Union of Chemistry by Mme. A. Dobry-Duclaux (Paris) and that of Theoretical and Applied Mechanics by Prof. J. M. Burgers (Delft). It was decided to form an International Committee on Rheology consisting initially of one representative each from all national groups devoted solely to the study of rheology, with power to co-opt individual rheologists from countries where no such groups as yet exist. The membership of the committee is temporary, until the national societies can elect their own representatives. Later in the Congress, the representatives of France (Prof. H. Weiss), Germany (Prof. F. H. Müller), Great Britain (Mr. A. G. Ward), Netherlands (Dr. R. N. J. Saal) and United States (Dr. R. S. Spencer) met under the chairmanship of Mr. Ward, and co-opted Prof. B. Gross (Brazil), Prof. M. Reiner (Israel) and Prof. A. Peterlin (Yugoslavia). It was resolved also to send invitations to rheologists in India, Japan and the Scandinavian countries. The purposes of the Committee were laid down as follows: "(1) To be a permanent body for organizing future International Congresses on Rheology, (2) to encourage new national organizations for the study of rheology, and (3) to act as co-ordinating body in other international co-operations in the field of rheology". Dr. R. N. J. Saal (Amsterdam) is acting as temporary secretary.

A third evening was devoted to a discussion on nomenclature and symbols. A number of reports formed a basis for the discussion, including that by Prof. J. M. Burgers and Dr. G. W. Scott Blair, published in 1949 under the auspices of the now defunct Joint Committee on Rheology. Dr. H. Leaderman (Washington, D.C.) reported on the still tentative but valuable "proposals for nomenclature for linear visco-elastic behavior" put forward by the Committee on Nomenclature of the (American) Society of Rheology. Following the discussion, certain recommendations were sent to Dr. Saal as secretary of the new International Committee.

At the Congress dinner, held in the Hall of Christ Church, Sir Ben Lockspeiser, as guest of honour, in reply to the toast of "The Guests", proposed by the president, summarized the history of the British Society of Rheology and recalled the First Congress held in Scheveningen in 1948. Dr. R. S. Spencer, president of the American Society, proposed "International Rheology", to which Mme. Dobry-Duclaux replied in French.

The Congress was closed by Prof. A. Peterlin (Yugoslavia), who expressed the gratitude of overseas rheologists to their British colleagues who had organized the Congress. Under the auspices of the newly formed International Committee, it is hoped that other equally pleasant and profitable congresses will be held in future years.

G. W. SCOTT BLAIR

RAT BEHAVIOUR

PERHAPS the rat, more than any other animal, is to be found in the laboratories of many of the biological sciences, and it was therefore a good subject for a miscellany of papers at the symposium on "Rat Behaviour", held at Birkbeck College (University of London), during July 9–10, by the Association for the Study of Animal Behaviour.

Topics covered at this symposium were: hormones and maturation, food-selection, convulsions, perceptual functions, stereotype behaviour and learning. J. T. Eayrs (Birmingham), in a paper entitled "Hormones and Central Nervous Maturation", described investigations of the functional relationships between endocrine and central nervous systems. In particular, the secretions of gonads and thyroid were varied, by ablation or injections, and behavioural concomitants studied by means of an ingenious battery of tests. In some cases, histological studies of the brain were also made; changes in bifurcations and lengths of dendrites, as well as vascularity, were observed. Analysis of results suggested that the functioning of certain postural co-ordinating centres is accelerated by the secretion of androgens, and that this facilitatory process may extend to higher forms of behaviour. With regard to thyroid functions, it has been widely accepted that the cerebral changes associated with untreated cretinism in man are irreversible. However, rat experiments still in progress furnish evidence that replacement therapy may restore both behaviour and cortical structure to normal. Experiments with the steroid hormones support in general the hypothesis that the hormone acts on a nervous mechanism which is genetically determined and which develops independently of the endocrine organ with which it is later associated. Thyroid hormone, on the other hand, although it may facilitate the functioning of quite specific centres, exerts an influence on central nervous maturation (there is some evidence that androgens do also); it is not known whether this is a primary or secondary effect.

S. A. Barnett (Glasgow) presented a paper entitled "Problems of Food Selection in Rats", in which he classified food preferences according to whether they were common to the species (for example, in the wild rat, preference for sweet foods, avoidance of aniseed oil) or dependent on the past history of the individual. Of the latter kind, experiments have shown that albino rats can usually select the nutritionally better of two foods, though past familiarity with a given food may result in its still being chosen in the presence of a better food. The development of poison shyness in wild rats was likened to the development of choices of beneficial foods. Food preferences, which are probably short-lived, may be induced by other members of the colony; for example, an unusual food may be brought to the nest by one rat and consumed by the others also. The choice of foods by young rats may to some extent be influenced by their tendency to orientate themselves on the mother; however, there is no evidence for detailed imitation. The rat's highly developed tendency to explore its environment and sample everything in it, together with its capacity for associative learning, leads to the consumption of a great diversity of foods. Dr. Barnett showed a film of experiments made on food preferences which had been lent by the Infestation Control Division of the Ministry of Agriculture and Fisheries.

M. R. A. Chance (Birmingham) read a paper on "Convulsions in the Normal Behaviour of Rodents". The experiments reported were done mainly on mice; but there was sufficient evidence to indicate that the results might be generalized to rats. When stimuli produce convulsions in a mouse, the amount of glycogen in the brain increases. Rises in blood-sugar and injection of the anti-insulin hormone also may increase the amount of glycogen but not to the extent produced by convulsions. It was thought, then, that large increases of glycogen in the brain might indicate behaviour of a convulsive nature. These increases have been found to occur with behaviour usually considered normal. For example, the falling posture adopted by a mouse when support is removed can be shown to protect it against hæmorrhage resulting from concussion at the end of the fall. The posture occurs within a fraction of a second, and so does the glycogen increment. The rigidity of the limbs and trunk suggests that many muscles participate in maintaining the posture, and that, therefore, not only a maximal rate of discharge, but multimotorneuronal discharge may be involved. It was considered, therefore, that audiogenic hyperexcitement, including convulsions, which are usually considered abnormal, should be thought of as part of the animal's normal repertoire. It was suggested that such behaviour is a type of emergency reaction appropriate to a situation in which there is an absence of clues for a more differentiated response. In these circumstances, *Peromyscus* exhibits an excessive flight reaction followed by aggressive saltation and the sequence ends in cataleptic postures. The volume of evidence already brought forward to show that audiogenic seizures are likely to occur in animals with pathological conditions is not evidence in itself that this mode of discharge is always pathological; the discharge may be thought of instead as indicating a release of the lower motor centres from cortical integration.

The three remaining papers came from psychological laboratories. I. M. L. Hunter (Oxford) summarized what is known of the role vision takes in rat behaviour. By means of extirpation experiments, it has been shown that vision is the dominant sense when a rat is learning an elevated maze, olfaction being secondary. Normal rats use both intra-maze and extra-maze visual stimuli; but the latter are especially important. In general, it appears that the rat's visual world is dominated by the more distant and more stable features of the environment. Hence in the enclosed maze, vision seems to be less important, olfaction and taction being dominant. Specially designed apparatus has been used for showing that rats are able to react to wave-length properties of red light, and that they are able to discriminate brightness, pattern and size. However, certain environmental features are more readily reacted to than others, and this has led to the suggestion that discrimination learning involves trying out a succession of 'hypotheses' until the correct one is found, that is, involves reacting now to this selected set of characteristics, now to that, learning meanwhile nothing about those characteristics 'not attended to'. Experiments have discredited this view; in general, it seems to be the entire discrimination situation to which the rat reacts. In brightness and in size discriminations, the rat may react to either the absolute or the relational features of the stimuli. It will react to relational features particularly if the stimuli resemble each other, or as a result of practice. The mechanism is not understood. It was concluded that the visual system functions most efficiently in

spatial orientation, that is, in the discrimination of distances and directions.

R. H. J. Watson (London) read a paper on "Stereotype Behaviour in the Rat". Such behaviour is one of many kinds often called abnormal which are conveniently studied in the rat. Mr. Watson considered in detail the difficulties encountered in arriving at criteria for normality and abnormality of behaviour. He considered in particular the suggestion made by Maier that behaviour should be considered normal if it were predictable from learning theory, abnormal otherwise. Using this criterion, Maier claimed that stereotype behaviour was abnormal, instigated by frustration resulting from presenting the rats with an insoluble problem. Mr. Watson reported experiments in which a more complex insoluble problem was used and in which a more complex stereotyping resulted. The analysis of the results indicates that, both in the insoluble problem and in a subsequent soluble problem, the behaviour conformed on a number of criteria to that which would be predicted from conventional learning theory. The results also suggested that such stereotypes would be self-perpetuating.

H. B. M. Hurwitz (London) read a paper, "Response Patterns in the Rat", which was also concerned with the predictive value of learning theory. In learning theories, it is commonly assumed that the strength of a response is a function of habit strength together with drive strength. The favourite experimental device for investigating the roles of these two factors is the Skinner box, in which rats learn to depress a lever to obtain delivery of food in a food trough. When the habit has been learnt, food is withheld and a count made of the number of lever-pressings produced before the habit is extinguished. Data obtained in this way are of basic importance to the theories of Hull and Skinner, for example. Mr. Hurwitz reported experiments using a modified Skinner box (which he demonstrated) with which the temporal and serial patterning of responses (both at the food trough and the lever) could be observed. Analysis of results suggested that the postulation of a secondary drive, frustration, could best explain the behaviour of the rat during extinction of the habit. Evidence for this would not have been forthcoming if conventional methods of analysing responses had been used.

General discussions on the papers were introduced by Profs. R. W. Russell (London) and W. S. Verplanck (Harvard). There were detailed discussions on methodology of the individual researches reported; more general topics covered included behavioural differences between various strains of rats, the use of the concept 'abnormal', and the predictive value of learning theories.

B. M. Foss

CAREERS IN CHEMICAL ENGINEERING

AN unexpected occurrence during the past few years has been the large decline in the numbers of men seeking admission to the universities for training as engineers, a decline noted not only in Britain but also to an even greater extent in the United States. Simultaneously, committee after committee has urged the need for more engineers in general, and chemical engineers in particular. Extensive training schemes will obviously be of little value unless the numbers of those willing to be trained can be greatly increased, and thus the issue by the Institution of Chemical Engineers of a small brochure entitled "Careers in Chemical Engineering" is most opportune (pp. 12+4 plates. Inst. Chem. Eng., 56 Victoria Street, London, S.W.1, 1953; 2*s*.). This explains clearly, in the simplest language, what chemical engineering is, how it developed, what a chemical engineer does, his opportunities, and how he can be trained; and it supplements its descriptions with admirable illustrations of plant of diverse nature, designed and constructed by chemical engineers. It is to be hoped that means will be found of bringing this pamphlet to the notice of every schoolboy leaving school, every schoolmaster, and every man at present engaged on National Service.

Modesty, unfortunately, seems to have compelled the authors to refrain from mentioning, except in the vaguest terms, the remuneration a chemical engineer may expect; in this materialistic age, one of the first questions asked by a young man selecting a career is: "What salary shall I get and what are the prospects?" This aspect might well be amplified in a future edition. A further line of thought is aroused by the almost parenthetical mention of teaching as an outlet for chemical engineers. Every academic member of the profession knows only too well the extreme scarcity of good teachers, and this fact must be regarded at the moment as the bottleneck in any scheme for the large expansion of chemical engineering training in Britain. Until steps are taken to induce a far larger proportion of chemical engineers than at present to go in for teaching, any increase in the numbers seeking training, or in funds for laboratory extensions, will be rendered of little avail.

H. E. Watson

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1952–53

THE report for 1952–53 of the director of research of the Wool Industries Research Association* records that the opening of new research laboratories at the Leeds headquarters of the Association has greatly increased the research potential. Three new blocks of laboratory buildings, erected since the end of the Second World War, were officially opened by Lord Swinton in October last year. With a staff now totalling 203, a very considerable variety of research topics has been and is being examined, ranging from *ad hoc* investigations of a purely consultative type, designed to assist industrialists in solving the day-to-day problems of a highly technical industry, to almost purely mathematical analyses of the system of forces acting upon fibre arrays during roller drafting, and of the corresponding and resulting fibre displacements.

Among the many research activities mentioned in the director's report, several are noteworthy for the ingenuity and modernity of the techniques employed. For example, in order to test the theory of carding which has been developed at the Association, an electrical counterpart or analogue of the three-part scribbler has been built. This shows in electrical terms what happens to a discontinuous feed, such as is obtained from the hopper of a card, as it passes

* Wool Industries Research Association. Report of the Director of Research for 1952–53 (Publication No. 196). Pp. 27. (From the Association, Leeds, 1953.)

through a scribbler of up to three swifts, and with one or more workers and strippers per swift. The device can also be used for predicting the effect of automatic controllers on the behaviour of the card, particularly in respect of possible hunting of the proposed control. This application of electronic computer techniques must mean the saving of much valuable time, to say nothing of the large amounts of actual raw material which would otherwise have to be processed to obtain the required results.

Fibre movement in roller drafting has been studied with the aid of radioactive tracers, the principle being to mix at random into a sliver a certain proportion of labelled fibres, and then to follow the movement of these fibres in the body of the sliver as it passes through successive drafting operations by standard procedures.

In the biological field, work on the identification of fibres by use of the sequence in cuticular scale pattern along the lengths of the fibres has led to a new classification of scale patterns for general use and has given more sensitive criteria for the identification of fibres. Such work may well have valuable applications outside the textile field—for example, in forensic science.

While the above examples may perhaps be cited as outstanding features of the Association's research programme, they are accompanied by a very great deal of less spectacular, but nevertheless invaluable, work of a routine nature.

The problem remains, and is recognized as fundamental by all workers in technological research, of getting the results obtained in the laboratory translated as rapidly as possible into practice in industry. The textile industry is probably no more backward in this respect than others; but it certainly remains true that much information which could, if thoroughly applied, make a very great difference to the technical efficiency of the industry, remains literally a closed book so far as the latter is concerned. This is not necessarily due to any strong prejudice against scientific research, but rather to the difficulty of securing adequate liaison between laboratory and the mill. The Wool Industries Research Association has made a notable attempt to surmount this difficulty by the appointment of liaison officers for this sole purpose. To quote the report on this matter: "The officers' visits give contributory members the advantage of verbal amplification of the Association's publications, and the advantage of discussing the firm's particular problems on the spot. At the same time these discussions enable the officers to keep the Association's staff informed of contemporary conditions and developments in the industry; thus research work can be directed along the most beneficial lines. Points of interest to members are discussed which often result in an investigation being pursued, to the members' very considerable advantage. The officers are also able to arrange for the co-operation of member firms in experimental projects which require large-scale trials or surveys. This two-way passage of information and of the use of equipment was scarcely anticipated when the liaison officers were appointed, but there is no doubt that it is now a valuable feature of their activities".

Such schemes of interchange are, of course, by no means novel in the industry, and are shared by other research associations and by university departments; but it is heartening for those whose foremost aim is the technical betterment of industry through sound research to see the process enlarged.

THE FRAMEWORK OF ASTRONOMY

FOR his inaugural lecture as Perren professor of astronomy in the University of London, which he gave last year at University College, London, Prof. C. W. Allen chose as his subject "The Framework of Astronomy". At the beginning of this lecture, which has now been published*, Prof. Allen points out that the work of the astronomer usually falls into one or the other of two categories: the expanding category, in which are the activities of elaborating, detailing, compiling and investigating individual objects for their own sake; and the contracting category, which includes the work of unifying, consolidating and standardizing. Very appropriate analogues are found in the political realm—namely, individualism and freedom in the first category, and regimentation and good order in the second. Both approaches are necessary in astronomy. The expanding individualism leads to new ideas and discoveries and also to long observational programmes with their risk not only of drudgery but also of the absence of discovery; equally important, however, is the regimentation mentioned under the contracting category, in which the co-ordination of the original facts and even, if required, the addition of missing links, tend to strengthen the subject. Such co-ordinated results frequently reveal not only regularities but also departures from anticipated laws, and the work of consolidation is responsible for results which can be used as a basis for further advances. The interconnexion of consolidated results from different branches of astronomy should lead to a strong stable framework of astronomical knowledge on which the future can build, and a great part of Prof. Allen's lecture is devoted to a consideration of the relation between the framework and the subject as a whole and also of the problems of constructing and using this framework. For the purpose of the lecture the following definition of 'framework' is given: "It is a complete assemblage of interconnected basis facts and quantities of astronomy prepared in readiness for use". It is admitted that no such framework exists; but as the possibility of its existence is not excluded, Prof. Allen discusses it under the above form.

An efficient framework for astronomy would contain information that represents it as a whole rather than the results of particular individuals and would be "concise, factual, and quantitative". An example is taken from the case of a comet. As every computer of cometary orbits knows, from at least three observations over about a week an orbit is computed on the assumption of parabolic motion and from this an approximate ephemeris enables observers to find it for a few weeks. Subsequent observations provide the data for a more accurate orbit, including the eccentricity, to be computed; then finality can be obtained when all the observations (probably extending over several months) are published and, taking planetary perturbations into consideration, a definitive orbit is computed. No improvement is possible with existing observations; but on the comet's next return the procedure could be repeated, and the sets of elements obtained, which represent the definitive orbits, then approach the ideal for the

* The Framework of Astronomy: an Inaugural Lecture delivered at University College, London, 1 May 1952. By C. W. Allen, Perren Professor of Astronomy in the University of London. Pp. 17. (Published for the College by H. K. Lewis and Co., Ltd., 1952.) 3s.

quantitative framework, that is, "it is efficient, representative, accurate and stable". This is typical of most branches of astronomy where there is a hope that improved values will become available and later work will reap the benefit, but there is also the fear that an improvement will change the adopted values and upset work in progress. The analogue of the definitive orbit cannot, however, be used in other branches of astronomy, because values never reach real stability, and in consequence astronomers may set up either a 'rigid' or a 'flexible' system.

In the rigid framework values of all the important constants, as close as possible to the best determinations at the time of adoption, are selected; but if these values are later found to be in error they are not changed, a correction being applied for those cases that require it, and such a correction can absorb all the effects of improvements in the experimental values. While a rigid framework of this type is necessary for accurate positional astronomy, the one in use at present does not attain perfection; but the data of its framework are used for the preparation of predictions, and, on comparing these with observational results, discrepancies frequently reflect an inaccuracy in the framework data. Whether such inaccuracies occur or not, the original data remain unaltered so that the process of predicting and observing can continue without interruption, and a clear interpretation can be placed on the observations. This rigid system is not, however, suitable in all cases, and in the more rapidly growing subject of astrophysics, where accuracy is relatively low, a flexible system that caters for perpetual improvement is more appropriate. Here, where the quantitative values vary, the progressive astronomer adjusts his outlook to the knowledge that the values are not precisely known, and he is pleased when the constants fluctuate within the domain of their probable errors. This flexible system shows hope of being available for the whole of astronomy, including astrophysics.

The theme is developed by Prof. Allen; but it is impossible in the limited space to deal with the numerous applications referred to, and this article can do little more than direct attention to the importance of the lecture. Towards the end three conditions, as follows, are mentioned as necessary for building an item into the framework of astronomy: a clear concept and suitable definition of the item; evidence that the item is vital to the progress of astronomy; and some estimate of its numerical value. The mean density of the universe is taken as an example on the above basis, although its value is not accurately known. While the density of the visible part made up of stars in external nebulæ is in the neighbourhood of 10^{-31} gm./cm.^{3}, this neglects the possibility of tenuous matter in the inter-nebular spaces. For various reasons, including the meagre observational evidence relating to this space, it is pointed out that, if we accept the extreme view of the reddening of the nebulæ as due entirely to gas, the estimate of the mean density of the universe would be increased by a factor of about ten thousand. When the mean density of the universe is open to such doubt, it is realized how far astronomy has still to go. In spite of this doubt, however, the density of the universe has its place in the development of cosmology, and, if it can be placed between the limits 10^{-26}–10^{-30} gm./cm.^{3}, it may possibly be restricted to a narrower range in a few years. "It is already built into the astronomy framework as a quantity to be watched and improved by all means available. If we had no other use for astronomy framework, it would at least be interesting and instructive to see it change as the years go by."

COMPOUNDS OF TERTIARY AMINES WITH NITROSYL CHLORIDE AND WITH DINITROGEN TETROXIDE

By Dr. ALAN E. COMYNS
University College, Gower Street, London, W.C.1

ALIPHATIC and aromatic tertiary amines have been found to react in inert solvents at − 78° with nitrosyl chloride and with dinitrogen tetroxide to yield coloured complexes. The aliphatic complexes are brown and the aromatic plum-coloured. They are insoluble in hydrocarbons but soluble in chlorinated hydrocarbons. The formation of such a complex by trimethylamine and nitrosyl chloride was observed by Jones and Whalen[1], but the generality of this reaction, and its significance in connexion with the reactions of amines with nitrosating agents, have not hitherto been recognized. Amines exhibiting this phenomenon include: trimethylamine, triethylamine, dimethylaniline, diethylaniline, *p*-nitroso-dimethylaniline and N-methyldiphenylamine. The three nitro-dimethylanilines did not form such complexes.

As the complexes are stable only at low temperatures, conventional methods of analysis are inapplicable; the molecular ratios in which the reactants had combined in two of the complexes were determined as follows. Known quantities of the two reactants were mixed at low temperature in pentane solution, and that in excess was quantitatively removed by pumping under high vacuum into a trap cooled in liquid air, the reaction vessel being maintained at − 78° or − 100°. The excess, collected in the liquid air trap, was then determined. The complexes studied by this means were those of dimethylaniline with nitrosyl chloride in excess, and of dinitrogen tetroxide with trimethylamine in excess. The results are shown in the accompanying tables.

These results establish the formation of $(C_6H_5)(CH_3)_2N.NOCl$ at − 78°, and of $(CH_3)_3N.N_2O_4$ at − 100°.

A good solvent for such complexes is a mixture of *sym.*-tetrachlorethane with ether (70 : 30 by volume). Qualitative observations of the absorption spectra of some of the complexes were made at − 78° in this solvent. Solutions containing an excess of dimethylaniline with nitrosyl chloride and with dinitrogen tetroxide had almost identical absorption maxima. That with nitrosyl chloride appeared at 398 mμ; and that with dinitrogen tetroxide at 404 mμ.

The electrical conductance of dimethylaniline with nitrosyl chloride was examined in the same solvent

Table 1. Dimethylaniline with Nitrosyl Chloride
Temp. = −78°
(DMA = dimethylaniline)

Initial ratio NOCl/DMA:	1·53	1·75	1·88	1·92	1·80
Final ratio NOCl/DMA:	1·09	1·06	1·06	1·00	0·91

Table 2. Trimethylamine with Dinitrogen Tetroxide
Temp. = −100°

Initial ratio Me_3N/N_2O_4:	1·5	1·5	1·5	1·9	2·1	2·9
Final ratio Me_3N/N_2O_4:	0·89	0·98	0·94	1·14	0·92	1·05

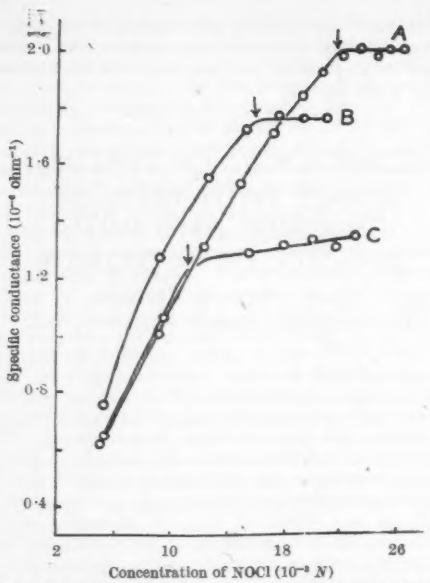

Fig. 1. Normality of dimethylaniline: *A*, 0·0216 *N*; *B*, 0·0158 *N*; *C*, 0·0110 *N*. Equivalence-points marked by arrows

at − 78°. The conductances of a solution of dimethylaniline of constant concentration to which different amounts of nitrosyl chloride had been added are shown in Fig. 1. The conductance rises rapidly with increase of nitrosyl chloride concentration until equimolecular quantities are present, and then remains nearly constant. For comparison, conductance curves for nitrosyl chloride alone, for a tetra-alkylammonium salt, and for dimethylaniline with hydrogen chloride at different concentrations

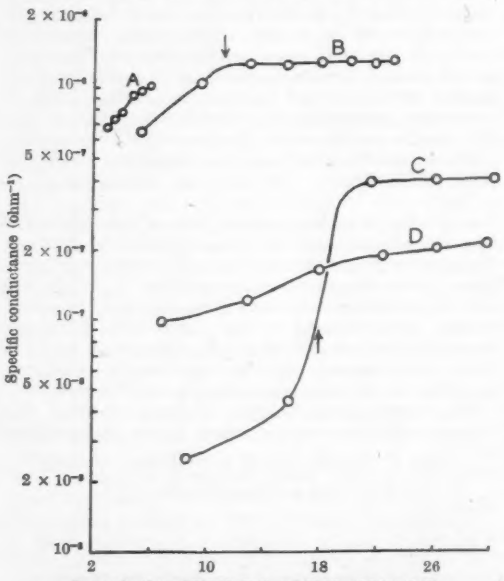

Fig. 2. *A*, Phenyl-trimethylammonium iodide; *B*, dimethylaniline (0·0110 *N*) with nitrosyl chloride (for comparison); *C*, dimethylaniline (0·0179 *N*) with hydrogen chloride; *D*, nitrosyl chloride. Equivalence-points marked by arrows

were also obtained under the same conditions, and are shown in Fig. 2. The conductance of the dimethylaniline–nitrosyl chloride complex is of the same order as that of the quaternary ammonium salt, and is much greater than that of dimethylaniline hydrochloride at similar concentrations.

These results strongly suggest that the complex should be formulated as a nitrosammonium salt:

$$[(C_6H_5)(CH_3)_2\overset{+}{N}.NO]Cl^-;$$

and the similarity of the absorption spectra indicates that the N_2O_4 complex has a similar structure:

$$[(C_6H_5)(CH_3)_2\overset{+}{N}.NO]NO_3^-.$$

The decomposition of the aliphatic complexes is rapid at −55°; the complexes of the aromatic amines are more stable, and their formation can be observed as a transient brown coloration when solutions of the reactants are mixed at room temperature, before the green colour of the nuclear nitroso-compounds appears. The decomposition products of the complex of trimethylamine with nitrosyl chloride were studied in detail by Jones and Whalen[1]; they included trimethylammonium chloride, dimethylammonium chloride, and nitric oxide. Trimethylammonium nitrate and nitric oxide are likewise products of the decomposition of the complex with dinitrogen tetroxide. The decomposition of the dimethylaniline–nitrosyl chloride complex yields *p*-nitrosodimethylaniline hydrochloride: and this is the product isolated when the reactants are brought together at higher temperatures[2].

The decomposition products obtained by Jones and Whalen from their aliphatic complex agree with those assumed by Hughes, Ingold *et al.*[3] in their suggested mechanism for the oxidative dealkylation of tertiary aromatic amines during nitrosation and nitration. The properties of the complexes obtained in the present work correspond closely with those predicted for the intermediate nitrosammonium ion postulated for this dealkylation.

I wish to thank Prof. E. D. Hughes for suggesting this investigation, and Dr. R. Passerini for recording the absorption spectra. [April 14.

[1] Jones and Whalen, *J. Amer. Chem. Soc.*, **47**, 1345 (1925).
[2] Neber and Rauscher, *Annalen*, **550**, 195 (1942).
[3] Glazer, Hughes, Ingold, James, Jones and Roberts, *J. Chem. Soc.*, 2671 (1950).

THE *Z*-ENZYME IN AMYLOLYSIS

It has been found by Peat, Pirt and Whelan[1] that crystalline β-amylase is unable to promote hydrolysis of amylose beyond about 70 per cent maltose. Progress is arrested by anomalous linkages, which however can be split by the '*Z*-enzyme', postulated for this purpose, that is present in, for example, soya amylase. Evidence was furnished by Peat, Thomas and Whelan[2] which suggested that the *Z*-enzyme is a β-glucosidase. The exact function of the *Z*-enzyme is clearly a matter of considerable interest and importance.

In experiments performed by us we have confirmed the undoubted existence of the arrest point, and, in general, our soya and crystalline amylases behave like those described by Peat *et al.* However, attempts to identify the *Z*-enzyme with β-glucosidase have been unsuccessful. If potato amylose limit β-dextrin is hydrolysed by soya amylase under conditions favourable to the action of the *Z*-enzyme, we should expect glucose to be liberated first, followed by maltose.

Traces of glucose as low as 2 μgm. can be detected by us using paper chromatography, employing the procedure of Partridge[3]. Since many times as much maltose is needed for a corresponding indication, it should be possible under suitable conditions to detect glucose among the reaction products as soon as maltose. In any case, the yield of glucose at an advanced stage of the reaction should correspond to about 1 per cent of the substrate used—if we assume the mean chain-length of the limit dextrin to be a hundred, a reasonable assumption in view of its blue value, method of preparation, etc.

We prepared amylose limit β-dextrin from potato amylose by the repeated action of crystalline β-amylase at *p*H 3·6, dialysis and recovery with butanol. Acting on a 0·1 per cent solution of this with soya amylase at *p*H 5 and 33° C., conditions very favourable to the action of the β-glucosidase of soya, we secured a rapid hydrolysis ultimately reaching beyond 90 per cent maltose. From concentrates of the reaction mixture at intervals, paper chromatograms were run on quantities equivalent to 2 mgm. of the dextrin substrate. Although maltose was absent at the outset but increased during the reaction, no glucose could be detected at 50 per cent hydrolysis. But a withdrawal after the reaction had passed 90 per cent and had apparently ceased revealed about 4 μgm. of glucose in 2 mgm. of reaction products, or 1 in 500. A control hydrolysis with maltose instead of the dextrin gave a fainter spot for glucose. Having regard to the probable action of traces of α-amylase in splitting off chains with an odd number of glucose resjdues from which glucose would be ultimately formed by the action of the β-amylase, it can be concluded from this experiment that the glucose formed was due to the latter cause, plus the action of the slight trace of maltase present. Furthermore, the changes in absorption values of the iodine colorations were indicative of the intervention of α-amylase in this reaction. It should be added that control chromatograms were run with glucose, maltose and maltotriose in all cases.

As it was possible that for some reason our soya amylase (prepared from soya beans by the method of Newton *et al.*[4]) was deficient in β-glucosidase (a test with cellobiose as substrate was positive), resort was had to emulsin. Two preparations, one specially made from sweet almonds by the method of Tauber, were used, each of which promoted a vigorous hydrolysis of cellobiose at *p*H 5, but each possessing faint α-amylase activity, as is well known[5,6]. In one experiment extract of emulsin was made to act at *p*H 5 and 33° C. on (*a*) 0·2 per cent amylose limit β-dextrin, (*b*) 0·002 per cent cellobiose, (*c*) 0·002 per cent maltose.

The concentration of β-glucosidic groups in (*a*) would presumably equal or exceed that in (*b*). Chromatograms showed hydrolysis in (*b*) to be well advanced in one day and virtually complete in two days. But in (*a*) a trace of maltose though no glucose was indicated in one day, and, after five days, glucose equivalent to 0·3–0·4 per cent of the amylose limit β-dextrin that had been taken. The same amount of glucose had been formed in (*c*) as in (*a*). Enough maltose was present in (*a*) after one day to have provided the maltase present thereafter with more substrate than in (*c*). The active cellobiose-splitting enzyme in the emulsin had failed to split glucose directly from the amylose dextrin, since the small amount formed would be fully accounted for by the actions of amylases and maltase.

Reaction mixture (*a*), brought to *p*H 3·6 and treated with β-crystalline amylase, was hydrolysed almost to completion. A preparation of the *Z*-enzyme from soya amylase behaved, in general, similarly to emulsin and was shown by its faint action on amylopectin limit β-dextrin to contain a faint trace of α-amylase.

These results raise doubts as to the identity of the *Z*-enzyme and β-glucosidase. In considering alternatives, one is continually brought back to α-amylase, traces of which could resemble the *Z*-enzyme. Peat *et al.*[3] ruled out this possibility after experiments in which the *Z*-enzyme was replaced with salivary α-amylase in great dilution. The latter increased the limit of action of crystalline β-amylase on amylopectin, whereas the former failed to do so. One aspect of the action of α- in the presence of a great excess of β-amylase was not discussed in their paper. The internal chains of amylopectin may be taken as averaging 5–6 units in length[7,8]. A single fission of an internal chain by α-amylase would expose, on an average, only three or four glucose residues at most to the action of β-amylase leading to only one more fission, whereas the corresponding result with amylose limit β-dextrin might well be fifty or more residues broken down to maltose. In the presence of great excess of β-amylase, a suitably small amount of α-amylase, while easily measured with amylose limit β-dextrin, could be missed when employing amylopectin, its limit β-dextrin or amylose glycollate as substrate. As regards the last-named, which was used by Peat *et al.*[3] in the determination of α-amylase, it should also be remembered that rate of fall of absorption value at 680 mμ promoted by α-amylase acting alone is relatively low when substrates of great chain-length are employed[9].

Another point is that salivary α-amylase is not typical of all α-amylases in one respect. It can attack α-1,4 glucosidic linkages close to the branch-points in amylopectin; only those connecting to the glucose residues actually involved in the 1,6 linkage are immune to its attack[10]. Malt α-amylase is an example of another type which can easily attack linkages only when they are five or six units away from a non-reducing end or branch-point[11–13]. This means that an internal chain of average length would be less readily split and, when split, this would be at such a position that the length of the chain thereby exposed to the action of β-amylase would be four units shorter than in the corresponding case with salivary amylase. Thus, malt α-amylase would split these internal chains less readily than salivary amylase, and there would be, per fission, less material available for β-amylolytic action. The α-amylase of the soya bean may resemble that of malt. Both occur in Nature in association with β-amylase, which takes over functions of saccharification.

Amylolyses of amylose and amylopectin by β-amylase containing a slight trace of α-amylase in parallel experiments present the following contrasting features. Because of the relatively large number of chain-ends on which the enzyme can act, β-amylase hydrolyses amylopectin in dilute solution many times faster than amylose. After completion of the purely β-action, subsequent action on amylopectin is restricted by the rate at which traces of α-amylase present can promote fissions of the internal chains. The shortness of the latter restricts both the affinity of some α-amylases and any further fission by the β-enzyme. This second phase, for one if not both of the reasons given above, must be exceedingly

Action of β-Amylase on α-treated Amylose and Z-treated Amylose

	Time of β-amylolysis (hr.)	0	0·25	0·5	1·0	1·5	2·5	5·75	9·25	20·25
Z-treated amylose	B.V. (680 mμ)	1·42	1·03	0·850	0·622	0·530	0·374	0·171	0·094	0·040
α-treated amylose		1·33	0·86	0·628	0·393	0·301	0·231	0·174	0·168	0·161

slow compared with the corresponding fission of amylose in the second phase. Thus, with a suitable addition of such amylase, amylolysis of amylopectin would stop (within the limits of experimental error), whereas that of amylose would continue.

The possibility that Z-enzyme action is due to a suitably low trace of α-amylase in our opinion merits further investigation. All the phenomena reported by Peat *et al.*[1,2] can be explained on such a basis—for example, the limits of action of phosphorylase in the presence and absence of the Z-enzyme. Even the failure of mercuric ions to inhibit the action of the Z-enzyme or emulsin is not conclusive proof that their actions are not due to α-amylases. The latter, unlike β-amylases, are not necessarily inactivated by mercury compounds[14], are not inactivated on the acid side of the *p*H optimum[15] and, when inactivated, the process takes time[16].

Our specimen of crystalline β-amylase is contaminated with a minute trace of α-amylase, as shown by its action at *p*H 6 on amylopectin limit β-dextrin.

One point we would like to add: an amylose described by Hopkins and Jha[17], which was prepared from potato starch by infusion at 63° C. followed by precipitation by thymol, was hydrolysed rapidly to 78 per cent by crystalline β-amylase at *p*H 3·6 reaching a limit at 80 per cent, whereas the amylose left behind in the starch granules, in its turn separated by thymol, was correspondingly hydrolysed only to 59 per cent with a limit at 64 per cent.

We are indebted to Dr. A. K. Balls for his gift of crystalline β-amylase.

R. H. Hopkins
R. Bird

Department of Applied Biochemistry,
University of Birmingham,
Edgbaston, Birmingham 15.

[1] Peat, S., Pirt, S. J., and Whelan, W. J., *J. Chem. Soc.*, 705 (1952).
[2] Peat, S., Thomas, G. J., and Whelan, W. J., *J. Chem. Soc.*, 722 (1952).
[3] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948); *Nature*, **164**, 443 (1949).
[4] Newton, J. M., Hixon, R. M., and Naylor, N. M., *Cereal Chem.*, **20**, 23 (1943).
[5] Kuhn, R., *Z. physiol. Chem.*, **135**, 12 (1924).
[6] Josephson, K., *Ber.*, **58** B, 2726 (1925).
[7] Illingworth, B., Larner, J., and Cori, G. T., *J. Biol. Chem.*, **199**, 631 (1952).
[8] Myrbäck, K., "Adv. Carbohydrate Chem.", **3**, 260 (1948).
[9] Hobson, P. N., Whelan, W. J., and Peat, S., *J. Chem. Soc.*, 3566 (1950).
[10] Whelan, W. J., and Roberts, P. J. P., *Nature*, **170**, 748 (1952).
[11] Myrbäck, K., and Sillen, L. G., *Svensk. Kem. Tid.*, **56**, 142 (1944).
[12] Schwimmer, S., *J. Biol. Chem.*, **186**, 181 (1950).
[13] Bird, R., and Hopkins, R. H. (unpublished).
[14] Caldwell, M. L., Weill, C. E., and Weil, R. S., *J. Amer. Chem. Soc.*, **67**, 1079 (1945).
[15] Schwimmer, S., Congrès International des Industries Agricole, Rapports, Paris (1948).
[16] Freeman, G. G., Thesis, Univ. Birmingham (1936).
[17] Hopkins, R. H., and Jha, B. K., *Biochem. J.*, **46**, 319 (1950).

We are glad of the opportunity of commenting on the communication of Prof. Hopkins and Dr. Bird, which raises the old doubt that Z-enzyme is in fact a weak α-amylase. In our paper[1] we emphasized the necessity of distinguishing Z-enzyme from α-amylase, and we concluded that the experiments there detailed did in fact do so. Prof. Hopkins now discounts the evidence of experiments in which amylopectin or amylose glycollate were the substrates on the grounds that these methods of detecting weak α-amylase activity were insufficiently sensitive, a conclusion for which no experimental evidence is afforded. We do not share this view; but we would point out that all our evidence is not based on experiments with amylopectin or amylose glycollate. One of these, which we regard as conclusively showing that Z-enzyme is not an α-amylase, has apparently been overlooked by Hopkins and Bird, although it conforms with their view that amylose is a better test substrate for α-amylase than is amylopectin. The results of this experiment are re-stated below, together with further details not reported at the time.

A highly purified amylose was used as the substrate in two parallel experiments in which were examined the successive actions of (1) Z-enzyme followed by β-amylase, and (2) a weak salivary α-amylase followed by β-amylase. The amylose (B.V. 1·47; for definition of B.V. see ref. 2) was digested with Z-enzyme for ten hours, during which time the B.V. fell to 1·42. When the amylose was similarly treated with the highly diluted α-amylase, the degradation was more extensive, the B.V. falling to 1·33. In each case the enzymes were then inactivated by heat and crystalline β-amylase was added. The changes in iodine-staining power observed are shown in the table.

These figures show that Z-enzyme action, which resulted in a smaller initial change in B.V. than did α-amylase action, enabled a more complete β-amylolysis to take place, although the rate of β-amylolysis of the α-treated amylose was at first greater than that of the Z-treated amylose. The limiting percentage conversions into maltose (measured by the copper-reducing power) supported the evidence of iodine-staining, being 89·4 per cent for α-treated amylose and 97·7 per cent for Z-treated amylose. Thus it is clear that Z-enzyme exerts a true debranching action, enabling complete β-amylolysis to take place. It does not fragment the amylose molecule after the fashion of α-amylase, the action of which enzyme is such as to leave iodine-staining fragments of the molecule still protected from β-amylase action by the anomalous (Z-labile) links.

A second point which calls for comment concerns the liberation of glucose by soya amylase. At the end of our paper[1] we suggest that the Z-labile links in amylose join single glucose residues to the main chains, and we quote certain facts which support this suggestion. The failure of Hopkins and Bird to detect the liberation of glucose by their sensitive paper-chromatographic method does not mean that β-linkages susceptible to Z-enzyme action do not exist in amylose, but simply implies that our suggestion limiting the branches to single glucose 'stubs' may be incorrect.

Stanley Peat
W. J. Whelan

Department of Chemistry,
University College of North Wales, Bangor.

[1] Peat, S., Thomas, Gwen J., and Whelan, W. J., *J. Chem. Soc.*, 722 (1952).
[2] *J. Chem. Soc.*, 924 (1948).

LETTERS TO THE EDITORS

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Audio-Frequency Spectrum of Atmospherics

THE observations on the low-frequency or 'slow tail' component in the waveform of an atmospheric described recently by Hepburn and Pierce in *Nature*[1] is of particular interest to us since we have been making similar observations for some years. The earlier observations made by Appleton and Chapman[2] dealt with the evolution of atmospheric waveforms. It was shown that many atmospherics consist of an oscillatory portion, composed of a sequence of quasi half-cycles of increasing duration, followed by a 'slow tail' of usually two rounded half-cycles. The oscillatory portion was found to move ahead of the slower disturbance as the distance of propagation increased. Further, the quasi half-period of the components of the oscillatory portion was found to obey a relation different from the 'slow tail'.

During the past few years we have supplemented the waveform observations by simultaneously recording the different frequency components in the spectrum of atmospherics from the response of a number of narrow-band tuned receivers[3]. The results given below were derived from an apparatus covering the frequency range 40 c./s.–16 kc./s. split by twenty-seven band-pass filters arranged logarithmically at three channels per octave. The amplitude frequency spectrum is presented directly on the screen of a cathode-ray tube and photographed with the corresponding waveform in order that there should be no doubt as to the type of atmospheric to which the spectrum relates. The records obtained show in a striking way the relative amplitudes of the spectrum components in the oscillatory portion and 'slow tail' of atmospherics as recorded at different distances from the source. Like the Cambridge workers, we are indebted to the Meteorological Office "Sferics" Organization for the location of sources of atmospherics.

In Fig. 1 is shown the relative amplitude of the frequency components $G(\omega)$ for atmospherics of the type described above as received at four different distances from the source. The parts of the spectrum

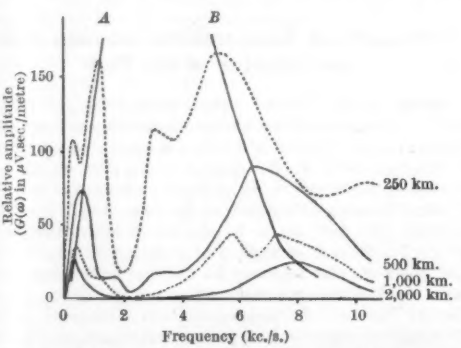


Fig. 1. Relative amplitude of the frequency components of atmospherics resulting from 'return strokes' of lightning flashes observed by day at different distances from the source. (*A*) shows the effect of distance on the maximum component in the 'slow tail', and (*B*) the corresponding effect for the higher-frequency oscillatory portion

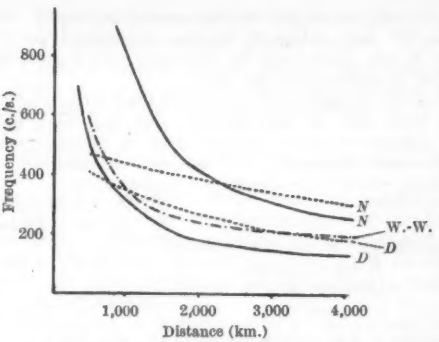


Fig. 2. Effect of distance on the frequency of maximum components in the 'slow tail' of atmospherics. Results as follows: ——, Chapman and Matthews; – – – –, Hepburn and Pierce; —·—·, Watson-Watt. *D*, day; *N*, night

resulting from the 'slow tail' and the higher-frequency precursor are indicated. As is to be expected, $G(\omega)$ decreases as the distance of propagation increases; but an interesting feature of the curves is that the frequency of the greatest component in the 'slow tail' decreases as the distance increases, while for the higher-frequency oscillatory portion the opposite effect occurs. The marked drop in the curves at frequencies in the region of 2 kc./s. and the widening of the trough with distance are indicative of selective attenuation of these components on an increasing scale with distance.

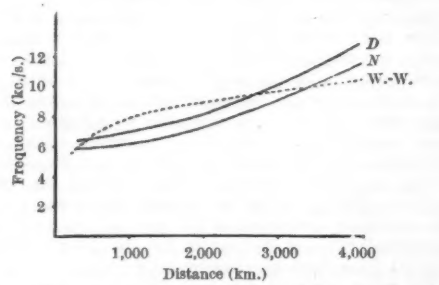


Fig. 3. Frequency of maximum components in the oscillatory portion of atmospherics compared with results deduced from waveform observations by Watson-Watt (indicated as W.-W.) at various distances from the source. *D*, day; *N*, night

An exact comparison of our results with those of Hepburn and Pierce[1] and Watson-Watt, Herd and Lutkin[4] for the 'slow tail' is not possible, since their data were obtained from a measurement of the quarter-period $\tau/4$, the time occupied by the first quarter-cycle of the 'slow tail' waveform. If we assume τ does, in fact, relate to maximum frequency components, and taking $1/\tau$ as the frequency at which these occur, we may compare the variation of this quantity with distance with our data. Fig. 2 shows our spectrum results for atmospherics received under both day and night conditions of propagation, together with the corresponding curves derived as above from the data supplied by Hepburn and Pierce[1]. Watson-Watt, Herd and Lutkin[4] did not specify day or night observations. All the results show the same general trend and indicate clearly that the frequency of the greatest component in the

'slow tail' for a given distance is higher at night than by day, whereas for the oscillatory portion, Fig. 3, not dealt with by Hepburn and Pierce, it is lower at night than by day.

This investigation is part of a long-term study on the spectrum of atmospherics and has been aided by grants from the Department of Scientific and Industrial Research. A detailed account of the present work is in course of preparation.

F. W. Chapman
W. D. Matthews

Wheatstone Physics Laboratory,
King's College,
London, W.C.2.
June 12.

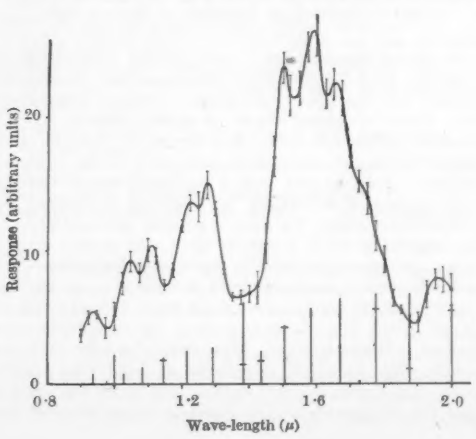
[1] Hepburn, F., and Pierce, E. T., *Nature*, **171**, 837 (1953).
[2] Appleton, E. V., and Chapman, F. W., *Proc. Roy. Soc.*, A, **158**, 1 (1937).
[3] Chapman, F. W., and Edwards, A. G., *Proc. U.R.S.I.*, **8**, Pt. 2, 351 (1950).
[4] Watson-Watt, R. A., Herd, J. F., and Lutkin, F. E., *Proc. Roy. Soc.*, A, **162**, 267 (1937).

Spectrum of the Night Sky in the Range 1·2–2 μ

We have recently obtained a series of spectra of the night sky in the wave-length region 1–2 μ. A lead sulphide cell was used as the detector in a grating spectrograph normally used for photographic spectroscopy[1]. The spectrum was scanned across the detector by rotating the grating, and spectra were obtained in the first order of the 15,000-lines/in. grating, using a 7–56 Corning filter to eliminate radiation of wave-length less than 0·9 μ.

The graph shows a plot of cell signal against wave-length, the average of five runs obtained at Saskatoon during the nights of June 14, 21 and 22, 1953. The spectrometer was directed towards a point in the sky about 15° above the northern horizon. Artificial lights were absent in this direction for a distance of at least twenty miles, and the atmosphere within the field of view of the spectrograph was not illuminated by the sun below 120 km. The spectral slit width used was 200 A., while the scanning-rate was 1 μ/hr. The standard deviation of the points obtained from individual runs is indicated by the length of the vertical lines through these points.

The most striking feature of the spectrum is the strong emission in the neighbourhood of 1·5 μ. It is possible to interpret this as being due to the $\Delta v = 2$ sequence of the OH rotation-vibration bands, the higher sequences of which were discovered in the night-glow spectrum by Meinel[2]. In the graph, below the spectrum, the positions and intensities of the OH bands as predicted by Heaps and Herzberg[3] have been indicated; the lengths of the vertical lines have been drawn in proportion to the predicted intensities. Since it is probable that the OH emission originates from a height of about 70 km.[4], it is to be expected that the band intensities will be strongly modified by atmospheric water-vapour absorption, and the horizontal strokes across the lines indicate the intensities as corrected for this absorption, the correction being, of course, rather uncertain[5].



Over the range 1·2–2 μ, the observed bands can be satisfactorily attributed to OH bands; at shorter wave-lengths the agreement is poor. We attribute this to the low signal-to-noise ratio in this region, since Kron[6] and Krasovsky[7], using detectors of greater sensitivity, have obtained general agreement with the OH bands up to 1·2 μ. Still, it is possibly worth noting that we have observed very intense radiation between 1·0 and 1·1 μ from the aurora, and it is therefore possible that low-level auroral activity, which is common in these latitudes, has distorted the night-sky spectrum in this spectral range.

Further investigations of the night sky and auroral spectra in this wave-length region are in progress.

The research reported here has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract *AF* 19(122)-152.

A. Vallance Jones
Herbert Gush

Physics Department,
University of Saskatchewan,
Saskatoon.

[1] Petrie, W., and Small, R., *Astrophys. J.*, **116**, 433 (1952).
[2] Meinel, A. B., *Astrophys. J.*, **111**, 555 (1950).
[3] Heaps, H. S., and Herzberg, G., *Z. Phys.*, **133**, 48 (1952).
[4] Roach, F. E., Pettit, H., and Williams, D. R., *J. Geophys. Res.*, **55**, 183 (1950).
[5] Hettner, G., *Ann. Phys.*, **55**, 476, 545 (1918).
[6] Kron, G. E., *Pub. Astro. Soc. Pacif.*, **62**, 264 (1950).
[7] Krasovsky, *Dok. Akad. Nauk., SSSR.*, **70**, 999 (1950).

Difference of Temperature between Pole and Equator of the Sun

Both Emden's[1] old hydrodynamic solar theory and the more modern thermo-hydrodynamical solar theory due to Bjerknes[2] lead to a higher temperature at the poles than at the equator of the sun. Bjerknes's theory is, however, more definite as regards the order of temperature difference to be expected. Bjerknes regards the sun as a baroclinic cosmic vortex in which there is a stratified circulation directed from the poles to the equator in the upper photospheric layer and a reverse circulation in the layer immediately below. According to him, sunspots, which he considers also to be vortices, originate in the sub-photospheric stratum; and the depth of a sunspot vortex is connected with the actual difference of temperature between the pole and the equator of the sun. This difference of temperature thus acquires a special importance in solar physics, and therefore

an observational determination of this quantity is greatly to be desired. To our knowledge, no measurement of this quantity is so far available. The reason for this lacuna is perhaps to be found in the difficulty of measuring the temperature of the sun with the required degree of accuracy; for the usual methods of measuring the effective temperature of the sun cannot be trusted to give an accuracy greater than ± 400° or 500°. But the temperature difference between the poles and the equator might be of the order of 100° or even less, so that some procedure capable of a higher precision is evidently required.

Some twenty years ago, Woolley[3] evolved such a procedure, which he called the method of "calcium ionization temperature" and which could give an accuracy of ± 50° or better. Recently, during a period of conspicuous solar inactivity and under perfect observing conditions, we were able to apply this method to the determination of the temperature difference between the pole and the equator. Our measurements were aimed at the evaluation of the equivalent widths of the λ 4227 line due to the neutral Ca atom and the λ 3933 line due to the ionized Ca+ atom at the pole and at the equator from nearly two hundred solar spectra secured under high dispersion. All these spectra yielded concordant values for the equivalent breadths. Our final evaluation of the pole–equator difference of temperature, which was done in accordance with Woolley's theory, led to the conclusion that the temperature at the pole is measurably higher than at the equator. In the calculations we used two alternative theoretical values for the ratio of the coefficients of continuous absorption at λ 3933 (k_1) and at λ 4227 (k_0) derived by Pannekoek[4] and by Chandrasekhar[5]. Pannekoek's value of $k_1/k_0 = 1{\cdot}35$ gave a temperature difference of 96° ± 18°, while Chandrasekhar's more recent value $k_1/k_0 = 0{\cdot}925$ gave 86° ± 16°.

One can derive the depth of a sunspot umbral column from Bjerknes's theory by using the observed difference of temperature between the pole and the equator. From the above values the depth of a sunspot vortex works out as 125 km. and 140 km. respectively. It is perhaps significant that these depths are of the same order as those deduced by Milne[6], Petrie[7] and Unsöld[8] from entirely different theoretical considerations. It is therefore not improbable that the umbral temperature of sunspots may yet turn out to be one of the solar constants as imagined by Milne many years ago.

Full details of our observational procedure and of our method of calculation are given in a paper which will form part of "Vistas in Astronomy", a book (now in the press) dedicated to Prof. F. J. M. Stratton, of Cambridge, on his seventieth birthday.

A. K. Das
K. D. Abhyankar

Kodaikanal Observatory,
India.
June 10.

[1] "Handbuch der Astrophysik", **4**, 221.
[2] Bjerknes, V., *Astrophys. J.*, **64**, 93 (1926).
[3] Woolley, R. v. d. R., *Mon. Not. Roy. Astro. Soc.*, **93**, 691 (1933).
[4] Pannekoek, A., *B.A.N.*, **3**, 207 (1926); *Mon. Not. Roy. Astro. Soc.*, **91**, 139 (1930).
[5] Chandrasekhar, S., *Astrophys. J.*, **102**, 395 (1945).
[6] Milne, E. A., *Mon. Not. Roy. Astro. Soc.*, **90**, 487 (1930).
[7] Petrie, R. M., *Mon. Not. Roy. Astro. Soc.*, **90**, 480 (1930).
[8] Unsöld, A., *Z. Astrophys.*, **2**, 209 (1931).

Thermodynamics of Irreversible Electrochemical Phenomena

In a recent letter in *Nature* Kemp[1] postulates, in opposition to our views[2–5], as the basic equation for the treatment of irreversible electrochemical processes, the formula:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}u/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \tilde{\mu}_k \mathrm{d}c_k/\mathrm{d}t, \qquad (1)$$

where s and u are the entropy and the energy per unit mass of the system; v is the specific volume, $\tilde{\mu}_k$ the electrochemical potential per unit mass and c_k the mass fraction of component k (see ref. 6 on this subject). In this connexion, we would like to make the following remarks.

(1) The energy in Kemp's equation is not well defined. In fact, such an equation has never been derived from first principles, that is, from the first and second laws of thermodynamics. In order to obtain such an equation it is in the first place necessary to write down the first law for open systems[7]. A consistent treatment[2,3] starting from the law of conservation for the density of total energy (which includes the density of internal energy, the density of macroscopic kinetic energy, and the density of electromagnetic energy) leads, instead of (1), to:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}u/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \mu_k \mathrm{d}c_k/\mathrm{d}t, \qquad (2)$$

where u is the *internal* energy per unit mass of the system and where μ_k is the chemical potential of component k. On introduction of the electrochemical potential $\tilde{\mu}_k$, (2) can alternatively be written:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}\tilde{u}/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \tilde{\mu}_k \mathrm{d}c_k/\mathrm{d}t - e\mathrm{d}\varphi/\mathrm{d}t, \qquad (3)$$

where e is the total electric charge per unit mass of the system and where the energy $\tilde{u} = u + e\varphi$ also includes the 'potential' energy $e\varphi$.

It is apparent from Kemp's letter that his energy u in equation (1) is identical with our $\tilde{u}$ of equation (3), although he obviously confuses this quantity with our u (equation 2), the internal energy. In fact, Kemp writes: "the intrinsic energy **U** does, by definition, include the totality of the energy contained in the system, so the addition of the term $e\varphi$ is tantamount to including the electrical energy twice over".

(2) It is rather surprising that one should arrive at the same results regarding the thermodynamical "driving force" acting on a charged component from equation (1) as from the different equation (2) or its alternative form (3).

(3) According to Kemp: "Since the change in **U** is quite independent of the path followed, it is quite correct to apply this equation [equation (1) or (2)] to any process whatever occurring in the system, reversible or irreversible". However, the application of Gibbs's equation to irreversible processes, that is, outside equilibrium, is, from a macroscopic point of view, an assumption only to be justified by statistical methods. In fact, it has been shown that the use of Gibbs's equation is only a good approximation for 'small' deviations from equilibrium[8].

(4) Finally, we would like to illustrate once more the importance of the term $e\mathrm{d}\varphi/\mathrm{d}t$ in equation (3), as well as the paradoxical results arrived at with equation (1). Consider a purely formal change $\mathrm{d}\varphi$ of the gauge of φ which is possible according to general electrodynamics, while $\mathrm{d}v = 0$, $\mathrm{d}c_k = 0$. Then $\tilde{u}$ changes as a consequence of the gauge transformation by an amount $\mathrm{d}\tilde{u} = e\mathrm{d}\varphi$, so that, according to equation (3):

$$ds = 0, \quad (4)$$

as it should be for this formal change.

Equation (1) would lead to the obviously wrong result $ds \neq 0$, whereas equation (2), which is entirely unaffected by the change of the gauge of φ, again yields the correct result, equation (4).

S. R. de Groot
P. Mazur
H. A. Tolhoek

Institute for Theoretical Physics,
University, Utrecht.

[1] Kemp, P. H., *Nature*, **170**, 1028 (1952).
[2] Groot, S. R. de, and Tolhoek, H. A., *Proc. Roy. Netherlands Acad.*, B, **54**, 42 (1951).
[3] Mazur, P., and Prigogine, I., *Mém. Acad. Roy. Blg., Cl. Sci.* (in the press).
[4] Prigogine, I., *J. Chim. Phys.*, **43**, C 80 (1952).
[5] Prigogine, I., Mazur, P., and Defay, R., *J. Chim. Phys.* (in the press).
[6] Guggenheim, E. A., *J. Phys. Chem.*, **33**, 842 (1929); "Thermodynamics" (especially chapter 10, North Holland Publishing Co., Amsterdam, 1949).
[7] Tolhoek, H. A., and Groot, S. R. de, *Physica*, **18**, 780 (1952).
[8] Prigogine, I., *Physica*, **15**, 272 (1949).

The above letter by Prof. S. R. de Groot and his co-workers has directed my attention to an error in my earlier communication[1], but has also made more obvious the fundamental error in their own paper[2].

In that paper they considered a medium showing a bulk motion and in which chemical reactions and flows of energy, matter and electricity were occurring. Their treatment was in effect a detailed consideration of the thermodynamics of a system consisting of an elementary volume of that medium. In virtue of the flows of matter, this system is an open one, and the work which it can perform is thus of four kinds: volume work, osmotic work, electrical work arising from changes in the concentrations of the charged components, and electrical work arising from changes in the electrical potential of the system. Using Gibbs's equation, we thus have, expressing the extensive properties in terms of unit mass:

$$T ds = du + p dv - \sum_k \mu_k dc_k - \sum_k e_k \varphi dc_k - e d\varphi, \quad (1)$$

or, introducing the electrochemical potentials:

$$T ds = du + p dv - \sum_k \tilde{\mu}_k dc_k - e d\varphi. \quad (2)$$

Equation (2) differs from that of my earlier communication, in which the last term on the right was erroneously omitted, and now leads to profoundly different conclusions.

The question of the validity of Gibbs's equation in relation to the present problem is of extreme importance, but is not the point now at issue. It may be noted, however, that de Groot and Tolhoek in their original paper[2] made use of Gibbs's equation without any hesitation.

If the formal change $d\varphi$ in the gauge of φ is now made at constant volume and composition, the specific internal energy u changes by an amount $e d\varphi$, corresponding to the formal change in the potential energy which has now occurred; all other terms on the right of equation (1) or of equation (2) are zero except the last, $-e d\varphi$. Hence we have the necessary result $ds = 0$.

Instead of equations (1) or (2), de Groot and his co-workers use for Gibbs's equation:

$$T ds = du + p dv - \sum_k \mu_k dc, \quad (3)$$

and the same argument shows that, contrary to their claim, the formal change in the gauge of φ now incorrectly yields $ds \neq 0$. Thus it is equation (3) and its various other forms (all identical in physical content) which are at fault, not equation (1). In fact, equation (3), which contains no electrical terms whatever, cannot possibly apply to the system under consideration.

When equation (1) is employed in place of equation (3) in the study of the system under consideration, it is found that the entropy production can be written as the sum of a product of thermodynamic forces and fluxes. Furthermore, with a suitable choice of forces and fluxes, the quantities μ_k and e_k appear in the expression for the entropy production only in the combinations $\tilde{\mu}^k$, provided that the condition $e = 0$ applies. This result implies that φ can be measured separately from the μ_k only if $e \neq 0$, that is, if a space charge is present in the system.

These conclusions are now identical with those of de Groot and Tolhoek, although these authors employed an incorrect form of Gibbs's equation. In arriving at these conclusions, however, they employed only the force equation (equation of motion for the kth component), which is not affected by any errors made in Gibbs's equation. The correct form, equation (1), of the latter now allows the same conclusions to be obtained directly from the entropy balance equation.

37 Friern Court,
Friern Barnet Lane,
London, N.20.

Peter H. Kemp

[1] Kemp, P. H., *Nature*, **170**, 1028 (1952).
[2] Groot, S. R. de, and Tolhoek, H. A., *Proc. Roy. Netherlands Acad.*, B, **54**, 42 (1951).

Structure of Meta-aminophenol

A single crystal of meta-aminophenol was previously studied[1] by means of rotation photographs only, whereby the identification of spots remains doubtful. We used the Weissenberg method and identified the spots by the method of Schneider[2]. We also studied the optical properties of this crystal.

The crystals were obtained by slow evaporation of alcohol solution. The crystal is orthorhombic with the following axial data: $a = 6{\cdot}31$ A., $b = 11{\cdot}12$ A., $c = 8{\cdot}60$ A.; with density (observed) $1{\cdot}195$, η the number of molecules per unit cell is 4. With these data, density was calculated to be $1{\cdot}206$.

The crystal was found to be optically negative with the values of refractive indices γ, β and α along a-, b- and c-axes, respectively: $\gamma = 1{\cdot}638$, $\beta = 1{\cdot}625$ and $\alpha = 1{\cdot}505$, and $v_a = 15°\ 30'$, where v_a is half the optic-axial angle.

If the molecules form a parallelism among themselves then the plane of the benzene ring will have a least value of refractive index perpendicular to the plane of the ring.

This result shows that the plane of the benzene ring is closer to the α- and β-directions than to the γ-direction.

Over-exposed oscillation photographs about the three crystallographic axes were taken in a Weissenberg goniometer using Ni-radiation. The spots were identified by drawing the requisite Weissenberg charts by the method of Schneider[2]. There are no absent spectra of (hkl). When l is odd $(h0l)$ is absent, but not $(0Kl)$. The probable space group is P_{ma} (C_{2v}^4).

Physics Department, M. N. Dutt
University of Calcutta. July 9.

[1] Caspari, W. A., *Phil. Mag.*, (7), **4**, 1276 (1928).
[2] Schneider, W., *Z. Krystallog.*, **69**, 41 (1928).

Structure of Selenium Tetrafluoride

In his interesting communication on the structure of SeF_4 [1], Mr. Bowen writes: "Only one model was found to give satisfactory agreement with the visually estimated ring intensities. This model has a distorted tetrahedron of fluorine atoms around the selenium atom with two opposite FSeF angles of 120° and the remaining four FSeF angles equal to 104·5° . . . the uncertainty in the angles [is] ± 10° ".

Now the relationship between the six internal angles in a distorted tetrahedron the corners of which remain equidistant from the centre is

$$\cos^2\frac{\alpha}{2} = -\cos\beta, \text{ or, } \cos\alpha + 2\cos\beta = -1,$$

where α is one of the *two* equal angles, while β is one of the *four* equal angles. For $\alpha = 120°$ we have $\beta = 104° 29'$, in agreement with Mr. Bowen's results. The α values of 110° and 130° yield, however, 109° 13′ and 100° 17′ for β, respectively. Hence 120° ± 10° for α corresponds with 104° 29′ ± *c.* 4° 30′ for β.

It may be of interest to note that, while the analogous six angles in a regular tetrahedron are equal to $109° 28' = \sec^{-1}(-3)$, those quoted by Mr. Bowen are $\sec^{-1}(-2) = 120°$ and $\sec^{-1}(-4) = 104° 29'$. I should like to add that angles formed by the maximum number of equally spaced radii with a common origin are equal to $\sec^{-1}(-1)$, $\sec^{-1}(-2)$ and $\sec^{-1}(-3)$, for the uni-, bi- and ter-dimensional space, respectively.

F. Lachman

Commonwealth Forestry Bureau,
Forest Products Research Laboratory,
Princes Risborough, Bucks.
July 27.

[1] *Nature*, **171**, 171 (1953).

Separation of Racemic Mixtures by Electrophoresis in a Strong Centrifugal or Magnetic Field

The separation of racemic mixtures of optical isomers is still limited, with rare exceptions, to the methods of Pasteur. For this reason the resolution of substances which seem identical in the test-tube but are importantly different in biology usually proves to be difficult and expensive both in research and in the chemical industry.

A theory for a generic method must be stated in terms of a gross model. The derivation of equations for the movement of a body in an electromagnetic field becomes almost prohibitively difficult except in the case of a sphere or an ellipsoid, as Alexander Kolin[1] has found in his study of the migration of visible particles. Furthermore, the molecules of water are far from infinitesimal in size when compared with the important racemic substances. Since the solvent is not a 'uniform homogeneous fluid', any application of the theorems of hydrodynamics will have at best only qualitative validity.

Consider a racemic mixture—*d*- and *l*-phenylalanine, for example—in a solution which will cause ionization as an acid. Suppose a low-voltage electrophoretic current to flow through the solution, and a strong centrifugal or a non-homogeneous magnetic field to be at right-angles to the direction of molecular migration.

A simple model may be pictured as follows. One may imagine a large number of small boats drifting on a lake, the boats being identical excepting that half have their rudders permanently fixed ten degrees to the right, and the other half ten degrees to the left. Let us further imagine a light wind in a given direction. The boats which were floating at random will tend to be turned with their prows in the same direction as the wind, since they can move in this direction with least resistance. One may ordinarily picture the two sets of boats as diverging at a constant angle according to the setting of the rudders. If there should be sufficient increase in momentum, however, the angular departure from the direction of the wind would increase until the boats are broadside to the wind. Here they will again be oriented with the wind after making a loop or node. In either case, the two groups of boats will travel with an increasing separation to the right and to the left from the direction of the wind.

This physical model corresponds to the specifications stated for the amino-acid mixture. The electrophoretic current corresponds to the wind, the ionization as an acid furnishes the prow and stern polarity, and the asymmetry of the molecules corresponds to the fixation of the rudders to the right or to the left. Finally, the action of the magnetic field upon the most strongly diamagnetic part of the molecule, or else of the centrifugal field upon the part of the molecule with greatest density, will provide the equivalent of a keel with a constant downward direction in the lake.

A sharp resolution, of course, would require the use of a solvent that will minimize the disturbance of Brownian movement. This can be achieved by cooling the water to the point of maximum density, or, in appropriate cases, by using a solvent which remains liquid at a much lower temperature.

Frederick C. Lendrum

College of Medicine,
University of Illinois.
Chicago 12.

[1] *Science*, **117**, 134 (1953).

The Delhi Pillar

The freedom from rusting of the famous iron pillar at Delhi has long been a subject of comment and has been attributed by some writers to the peculiar properties of the ancient iron from which it is forged. Although some particulars of its history are obscure, it seems certain that the pillar dates from about the fifth century A.D. and is roughly 1,500 years old. The immunity of iron from rusting over such a long period is a striking phenomenon and it may therefore be of interest to report the results of some experiments that were made to ascertain the reason for this.

Table 1. Atmospheric Corrosion of Steel and Zinc

Exposure station		Corrosion rate. Mils (0·001 in.) per year	
		Steel*	Zinc
Delhi	1950–1951	0·23	—
	1951–1952	0·17	0·006
Godalming	1951–1952	1·7	0·042
Sheffield	1951–1952	4·2	0·51
Khartoum	Average, 9 yr.	0·1	0·02
Basrah	,, 8 ,,	0·6	0·04
Singapore	,, 10 ,,	0·6	0·04

* The specimens exposed at Delhi, Godalming and Sheffield were of steel containing 0·3 per cent of copper. This material is roughly one-quarter less corrodible than ingot iron, of which the Khartoum, Basrah and Singapore specimens were made.

Table 2. Meteorological Observations at New Delhi (1951)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
Relative humidity, per cent, 0830h.	74	52	53	42	35	41	63	74	63	50	50	69
Relative humidity, per cent, 1730h.	46	24	33	21	21	26	48	60	52	37	42	47
Rainfall (in.)	0·9	0·0	2·1	0·9	0·1	0·5	4·8	3·1	4·1	0·3	0·6	Nil

Small specimens, 4 in. × 2 in., of steel ($\frac{1}{8}$ in. thick) and zinc (1/20 in. thick) were exposed in the open air near the pillar for one year and their losses in weight were then determined after the corrosion products had been removed. Their corrosion-rates found in this way are compared in Table 1 with the results of similar tests made at other stations, both at home and overseas.

It is clear that the corrosive conditions at Delhi are very mild. Indeed, the zinc specimens were so little corroded that they retained much of their original polish after a year's exposure there. In my view, therefore, the lack of serious rusting of the pillar is to be attributed to the mildness of the local climate rather than to any intrinsic superiority in the corrosion resistance of the iron itself.

This conclusion is supported by a study of the meteorological data for Delhi, for which I am indebted to the Indian Meteorological Office. The figures for 1951, which fell within the experimental period, are given in Table 2.

It is known from the classical researches of W. H. J. Vernon that the relative humidity of the air is the primary controlling factor for the atmospheric corrosion of iron and that little or no rusting occurs unless the humidity exceeds 70 per cent. The records show that this critical value would only be reached at Delhi for a short time during the whole year. Presumably, too, the sulphur pollution of the atmosphere, which, as Vernon demonstrated, controls the corrosion rate when the humidity reaches the critical value for rusting, is but slight in the neighbourhood of the iron pillar.

The late Sir Robert Hadfield, who was very interested in the Delhi pillar and published an analysis of its iron, seems to have been of a similar opinion, for in one of his papers he prefaces his remarks about this and other specimens of historical interest by observing that "in dry air the action of corrosion may be very slight".

J. C. Hudson

British Iron and Steel Research Association,
140 Battersea Park Road,
London, S.W.11.
June 30.

High R^z Frequency in the Blood of Australian Aborigines

In blood genetic surveys conducted prior to 1948 on Australian aborigines it was shown[1] that these natives possessed the gene R^z, and that its distribution in various Australian States appeared to be patchy. In all, the gene was demonstrated seven times (3 per cent) in 234 aborigines. It was found in natives of Queensland and the Northern Territory, but not in fifty-nine natives of South Australia.

One of us (J. B. B.) is at present engaged on an extensive field survey of aborigines in Western Australia and is also collecting blood samples for testing in Melbourne.

To date, the results in relation to the gene R^z are as follow :

Location	Number tested	R^1R^z	R^2R^z	R^zR^z
Cundeelee Mission	22	2	1	0
Wiluna	33	2	1	1
Cosmo Newberry	59	2	–	0
Mulga Queen	16	0	–	0
Mount Margaret	45	1	–	0
Jigalong Mission	47	7	–	1
Marble Bar	108	1	–	0
Pilgangoora	65	3	–	1
	395	18	2	3

Only seventeen samples of type Rh_1Rh_2 from Cundeelee Mission and Wiluna in a total of 134 found have been tested with anti-hr'' (anti-e) serum owing to shortage of this testing reagent. Other examples of R^zR^z probably remain undisclosed in the series. The purpose of this letter is to report finding the genotype R^zR^z in Western Australia, three examples of which occurred in 395 unmixed aborigines tested in the present survey, and the high R^z frequency averaging 6 per cent, but approaching 20 per cent in certain tribes. One previous example of R^zR^z has been reported[2] in the blood of an aboriginal in Queensland.

Tests have been made to date covering the *A–B–O*, *M–N–S*, *Rh*, *P*, *Le*^{a}, *Fy*^{a}, *K*, *Lu*^{a} and *He* blood groups. It has, however, been necessary to limit severely the number of tests performed with some anti-sera owing to world shortage. It can be said as a progress report that in Western Australian aborigines the percentage of *P*+ is about 25, *Fy*^{a}+ is almost 100, *Le*^{a}+ is about 3·5, while *S* of *M–N*, *K*, *Lu*^{a} and *He* antigens are absent, or rare. One example of the *Rho* variant presumably homozygous (*CD*^{u}*e*/*CD*^{u}*e*) has been detected in the series; the sample showed weak agglutination with some highly potent anti-*Rho* sera, and failed to agglutinate with others. As judged by strengths of agglutination with specially selected testing sera, it is suspected that an occasional variant occurs at the other *Rh* loci also. Tests made to date on 125 random adult blood samples have failed to show any evidence of the sickle-cell trait in this population.

The full blood-grouping results will be reported after the field survey concludes about the end of 1953.

R. T. Simmons
J. J. Graydon

Commonwealth Serum Laboratories,
Melbourne, Australia.

J. B. Birdsell

University of California,
Los Angeles.

[1] Simmons, R. T., and Graydon, J. J., *Med. J. Australia*, **2**, 113 (1948).
[2] Sanger, R., Walsh, R. J., and Kay, M. P., *Amer. J. Phys. Anthrop.*, N.S., **9**, 71 (1951).

Theory of Revertible Mutations

GENE mutation studies of a single locus—the incompatibility gene complex in *Oenothera organensis*—revealed mutations of two types: (1) permanent inactivation or losses; (2) revertible changes which included delayed mutations.

Both of these occurred spontaneously and were induced by X-rays. Because of the novelty of revertible X-ray mutations the nature of the induced changes has been discussed at some length[1] and it was shown that they were probably due to genuine gene mutations which reverted back to the normal allele after one to seven cell divisions after mutation. It was suggested that the revertible mutations were due to losses of only a fraction of the total number of polypeptide chains of which the gene is presumed to be composed. It followed that the reversion was due to the sorting-out of the unmutated from the mutated chains, the revertible being the unmutated chains and the delayed being the mutated chains, as suggested by Darlington[2] for delayed mutations induced by mustard gas.

Although alternative explanations for the revertible changes in *Oenothera* were difficult to reconcile with the data, the possibility of a dauermodification due to the cytoplasm was not entirely excluded. Similar studies in *Prunus avium* have now proved beyond doubt that these revertible changes are genuine gene mutations. As in *Oenothera*, the incompatibility gene consists of at least two mutationally distinct parts—or on one definition, two genes. One controls the pollen and the other the style reactions: these can readily be distinguished by precise tests.

The incompatibility tests of a seedling of *Prunus avium* which was obtained by self-pollination with a pollen grain carrying an X-ray induced mutation are given in the accompanying table.

RESULTS OF TEST CROSSES WITH A MUTANT SEEDLING OF *Prunus avium* INDUCED BY X-RAYS

The incompatibility of the mutant on the parent shows that the incompatibility alleles S_3 and S_4 are active in the pollen. The self-compatibility and the compatibility as female with the parent shows that one of the alleles is inactive in the style

	Result	
Mutant $S_{3'.4'}$ selfed	+	
Parent $S_{3.4}$ × Mutant $S_{3'.4'}$	−	Both alleles active in pollen
$S_{3.4}$ × " $S_{3'.4'}$	+	$S_{4'}$ pollen functions
$S_{4.5}$ × " $S_{3'.4'}$	+	$S_{3'}$ pollen functions
Mutant $S_{3'.4'}$ × Parent $S_{3'.4'}$	+	$S_{3'}$ or $S_{4'}$ not active in style

The seedling is self-fertile, which shows that one of the S alleles is not operating in either the pollen or style or both. The seedling fails as male on the parent, $S_{3,4}$, and is compatible on $S_{3,5}$ and $S_{4,5}$, which proves that it is a heterozygote and that both $S_{3'}$ and $S_{4'}$ are fully active in the pollen. The incompatibility of the seedling when crossed with the parent $S_{3,4}$ shows that one of the alleles is not operating in the style.

There seems to us to be only one way in which this mutation could have arisen. A simultaneous mutation was induced in the two parts of the S complex: the 'stylar' mutation remained permanent and the 'pollen' mutation—which must have occurred to have given compatibility to the original pollen grain which begot the seedling—reverted to normal. The simultaneous occurrence after X-rays of a permanent 'stylar' mutation and a revertible 'pollen' mutation would require a high degree of improbability if their causes were independent, as they would be if the revertible changes were not genuine gene mutations.

The different post-mutational histories of the two parts of the S complex show that not only are the two parts independent in their mutation but also in their reversion.

The evidence of La Cour and Rutishauser[3] on sub-chromatid breaks, which is the cytological basis of the theory of revertible mutations, shows that they do not occur in the resting nucleus or at metaphase. It is significant that the revertible mutation in *Prunus* occurred with irradiations given at a period which would include the prophase stage. All the permanent 'complete' mutations were induced by treatments given in the resting stage and not including any prophase nuclei.

The complementary nature of the cytological and genetical evidence not only confirms the link between chromosome breakage and gene mutation but upholds the theory that revertible mutation is due to a loss of a proportion of the polypeptide chains of the gene followed by recovery of the unaffected remainder.

D. LEWIS
LESLIE K. CROWE

John Innes Horticultural Institution,
Bayfordbury, Hertford. Aug. 13.

[1] Lewis, D., *Heredity*, **5**, 399 (1951).
[2] Darlington, C. D., *Publ. Stazione Zool. Napoli.*, Supp. **22**, 1 (1950).
[3] La Cour, L. F., and Rutishauser, A. [see following communication].

Chromosome Breakage Experiments with Endosperm: Sub-chromatid Breakage

ERRORS in chromosome separation at anaphase appear in the interval following X-raying which follows the period when the chromosomes are susceptible to breakage[1]. Similar errors appear with various chemicals, but not always in association with the later occurrence of chromosome breakage[2–5], and with heterochromatic segments after cold treatment[6].

Earlier accounts give these errors in two forms—intercalary adhesion and terminal attachment. Typical of many intercalary types is the chiasma-like structure at the point of attachment. Levan[7] noted that the error was scarcely attributable to stickiness, since breakage of the bridge was generally away from the point of attachment. Darlington[8] invoked two-plane splitting of a monid structure to explain similar

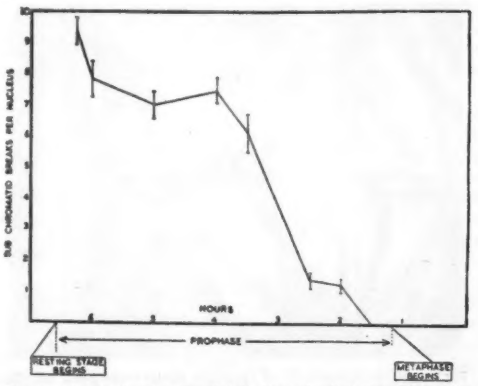


Fig. 1. Graph showing the distribution of sub-chromatid breaks deduced from the point effects at anaphase in *Scilla sibirica* endosperm ($3x$, $n = 12$) after a dose of 54 r. The onset of complete breakage at 6½ hr. (seen in metaphases) limits the point effect to a prophase origin

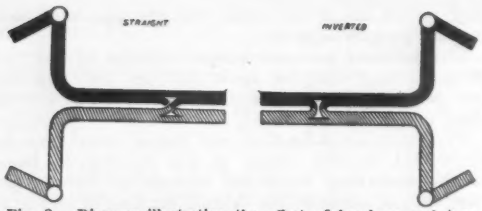


Fig. 2. Diagram illustrating the effect of breakage and two possible kinds of reunion of half-chromatids, to give homologous intercalary point effects. *Note*: We believe, however, that smaller sub-units or 'monids' can be involved. The later early anaphase condition is depicted for simplicity. On the sub-chromatid theory one point effect is derived from two sub-chromatid breaks

errors at meiosis. D'Amato[5] proposed isochromatid breakage with reunion of four broken ends at one point. Neither of the last two views is compatible with the following evidence obtained from *Scilla* endosperm.

Fixations were made at half-hourly intervals, 1–6 hr. following a radiation dose of 54 r. (temperature 18° C. throughout).

The onset and frequency of sub-chromatid breaks as deduced from the errors observed per anaphase nucleus are shown in Fig. 1. The complete mitotic cycle takes approximately 48 hr. A 6½-hr. fixation in endosperm undergoing wave mitosis showed metaphases with chromatid breakage (*B′*) and anaphases with adhesions alone. Both primary and secondary effects therefore most likely overlap.

Close scrutiny of affected anaphases reveals configurations more complex than any hitherto described. These involve associations at non-homologous loci and can be classified as intrachromatid and interchromatid. The first gives loop structures. The last, which can involve sister or non-sisters, gives configurations with unequal arms distal to the point of union. These aberrations, together with the chiasma-like structure evident in intercalary configurations, provide the clue to the origin of the point effect.

Such points, as Darlington[8] assumed, clearly involve sub-chromatids, a condition being produced by breakage and reunion, simulating crossing-over, as inferred in Fig. 2 (cf. Fig. 3). The origin of configurations involving non-homologous loci then becomes clear. They result from sub-chromatid breakage and reunion in coiled and overlapping chromatids at prophase (Fig. 4).

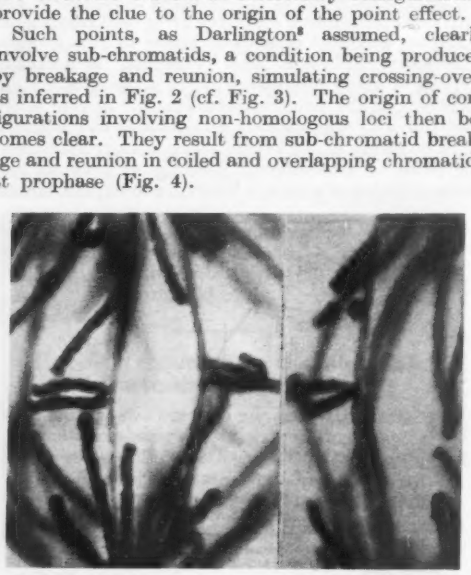


Fig. 3. Microphotographs of anaphase nuclei from *Scilla sibirica* endosperm five hours after 54 r. (× 900). The left-hand nucleus shows two intercalary point effects. Note sub-chromatid structure and evidence of inverted union (cf. Fig. 2). On the right, a part nucleus with homologous interchromatid and non-homologous intrachromatid point effects in one chromosome (cf. Fig. 4)

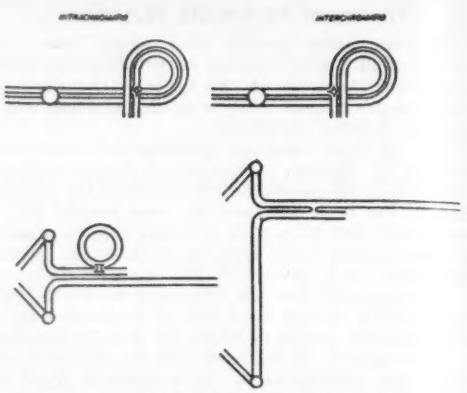


Fig. 4. Diagram illustrating the origin of point effects at non-homologous loci through coiling in prophase chromosomes. The later early anaphase condition is depicted for simplicity

The idea of partial chromatid breakage is not new. The supporting evidence has generally, however, been unclear and indecisive[9,10]. Two observations are in line with ours. They agree in the time at which, probably, sub-chromatid breakage universally occurs with treatment, namely, at prophase. Thus Swanson[11] obtained partial chromatid breakage with irradiation of generative nuclei in *Tradescantia* pollen, and Slizynski[12], likewise, in salivary gland nuclei irradiated earlier in ontogeny.

Apparently the centromere, although passive to chromosome breakage in the resting nucleus, limits sub-chromatid breakage at prophase. Rees[13] obtained evidence of centromere interference in the position of point effects. In our material, also, point effects are extremely rare near the centromere. We can but conjecture if this is also true of thoroughgoing chromatid breakage.

The main conclusion to be drawn from our *Scilla* experiments is that regularly sub-chromatid breaks are induced by treatment during prophase but not during the resting stage and metaphase.

Finally, there is no denying the probability of a causal relationship between sub-chromatid breakage and delayed mutation. It is significant that Lewis and Crowe[14] obtained a revertible mutation in *Prunus* with irradiation of prophase: only stable 'complete' mutations occurred with treatment of the resting stage. Likewise, it is significant that mosaics never occur in *Drosophila* with X-ray treatment of the sperm.

A fuller account of these observations is being given elsewhere.

L. F. La Cour
A. Rutishauser
John Innes Horticultural Institution,
Bayfordbury, Hertford. Aug. 13.

[1] Darlington, C. D., and La Cour, L. F., *J. Genet.*, **43**, 180 (1945).
[2] Darlington, C. D., and Koller, P. C., *Heredity*, **1**, 187 (1947).
[3] Östergren, G., *Bot. Notiser.*, **4**, 376 (1948).
[4] Levan, A., and Tjio, J. H., *Hereditas*, **34**, 453 (1948).
[5] D'Amato, F., *Pubbl. della Stazione Zool. di Napoli*, Supp., 22, 1 (1950).
[6] Darlington, C. D., and La Cour, L. F., *J. Genet.*, **40**, 185 (1940).
[7] Levan, A., *Hereditas*, Supp., p. 325 (1949).
[8] Darlington, C. D., *Hereditas*, Supp., p. 189 (1949).
[9] Nebel, B. R., *Amer. J. Bot.*, **24**, 365 (1937).
[10] Marshak, A., *Proc. U.S. Nat. Acad. Sci.*, **25**, 502 (1939).
[11] Swanson, C. P., *Proc. U.S. Nat. Acad. Sci.*, **33**, 229 (1947).
[12] Slizynski, B. M., *Genetics*, **35**, 27 (1950).
[13] Rees, H., *Heredity*, Supp., **6**, 234 (1952).
[14] Lewis, D., and Crowe, L. K., *Nature* [see preceding communication].

A New Method of Estimating the Survival-Rate of Anopheline Mosquitoes in Nature

THE sporozoite infection-rate of anopheline vectors of malaria dissected upon the day of capture depends upon, among other variables, the proportion which have survived long enough for the completion of the extrinsic cycle of the malaria parasite in them. If wild-caught mosquitoes are kept alive after capture for a period equal to that of the extrinsic cycle, the sporozoite-rate found at the end of this period would represent the proportion with any infection, however immature, at the time of capture. The ratio between the immediate and delayed sporozoite-rates is directly proportional to the chance of survival of the mosquitoes from the time that they receive an infective feed until sporozoites can be found in the salivary glands. The other variables influencing the sporozoite-rate, such as the infectivity of the population, can be ignored as they have the same effect on the two rates. The pattern of mosquito mortality is thought to be geometric, all age-groups being on average exposed to the same risk of mortality[1], so that it is possible to establish a simple mathematical relationship between the daily chance of survival and the ratio between the sporozoite-rates, where p = the probability of a mosquito surviving through one day, and n = period in days for completion of the extrinsic cycle in the mosquito (1 is subtracted from this as the mosquitoes are on average at least one day old at the time of the infective blood meal):

$$\frac{p^{n-1}}{1} = \frac{\text{Immediate sporozoite-rate}}{\text{Delayed sporozoite-rate}}$$

$$\text{or } \log p = \frac{\log \text{ ratio}}{n-1}$$

whence p can readily be calculated.

We have recently made observations in a coastal area of tropical East Africa where *Anopheles gambiæ* and *Anopheles funestus* are the principal vectors of malaria. The results of dissections made over a period of three months (September–December 1952) are summarized in the accompanying table. The delayed sporozoite-rate is based on dissections done from thirteen days onwards after capture, as direct observations of the period of the extrinsic cycle showed that thirteen days (n) was the time required for the appearance of sporozoites of *Plasmodium falciparum*, the predominant parasite, under the prevailing climatic conditions.

The figures show that in this area the average mortality of the *A. gambiæ* population was of the order of 7 per cent per day, and that of the *A. funestus* population of the order of 8 per cent. Such low values are consistent with the well-known efficiency of these species as malaria vectors and the intensity of the malaria caused by them. The suggestion that *A. funestus* has a higher mortality-rate than *A. gambiæ* was confirmed by observing the mortalities among mosquitoes kept in cages.

	Immediate dissections		Delayed dissections		Ratio: Immediate / delayed	Calculated value of p
	Total dissected	Sporozoite-rate (per cent)	Total dissected	Sporozoite-rate (per cent)		
A. gambiæ	700	$4{\cdot}7 \pm 0{\cdot}6$	382	$11{\cdot}0 \pm 2{\cdot}6$	0·43	0·93
A. funestus	1,119	$3{\cdot}4 \pm 0{\cdot}3$	593	$9{\cdot}6 \pm 1{\cdot}5$	0·35	0·92

An estimate of the natural mortality of vector species, together with other malariological indices, is a prerequisite of the planning of malaria control schemes by imagocidal methods. There is a possibility that the principle of this method of estimating mortality may be applicable to other insects which act as hosts to parasites with a known developmental cycle.

C. C. DRAPER
G. DAVIDSON

Ross Institute of Tropical Hygiene,
Keppel Street,
London, W.C.1.
June 5.

[1] Macdonald, G., *Trop. Dis. Bull.*, **49**, 569 (1952).

Abnormal Embryonic Development in *Drosophila* induced by Ultrasonic Treatment

WE have found that treatment with ultrasonics of eggs of *Drosophila melanogaster* can induce abnormal embryonic development, and the method provides a tool for use in experimental embryology. Ultrasonic intensities insufficiently great to cause the disruptive effects of cavitation and the associated chemical effects may yet induce streaming movements within the egg so that nuclei, cytoplasm and yolk are left in unusual positions. Abnormal development may then follow.

Large numbers of eggs at the same developmental stage were treated on agar disks in a water medium under controlled conditions of uniform ultrasonic intensity, at a frequency of 1 Mc./s., at room temperature. The apparatus has been described elsewhere[1]. Subsequent development was investigated using permanent stained serial sections fixed at intervals up to 20 hours after treatment. The mode of action of the ultrasonics was confirmed by visual microscopical observations made on dechorionated eggs during treatment, using an ultrasonic stage generator similar to that used by Harvey, E. N., Harvey, E. B., and Loomis, A. L.[2], when they observed the whirling of chloroplasts by ultrasonics in leaves of *Elodea*.

Embryos treated at the syncytial blastoderm stage (two hours after laying at 25° C.) were usually affected in the posterior region. The pole cells were most easily set in motion; they rotated rapidly and created a local vortex into which blastoderm nuclei were drawn, followed by yolk and cytoplasm from the interior of the embryo as the disturbance spread (Fig. 1). After treatment at ultrasonic intensities of 0·3–0·5 watts/cm.^{2} for 30 seconds at the syncytial blastoderm stage, 91 embryos were incubated for a further 10–18 hours at 25° C., and then fixed for sectioning. Twenty-three embryos showed normal development. Ten showed only slight irregularities such as abnormal segmentation or absence of gonads. Twenty-three exhibited abnormal spatial relationships between organs or showed absence of certain organs, the involution of the head and the hypodermis being most markedly affected (Fig. 2); no supernumerary organs were found. Eighteen showed no organogenesis but differentiation of cells occurred (for example, the nervous system was differentiated into ganglion and fibres,

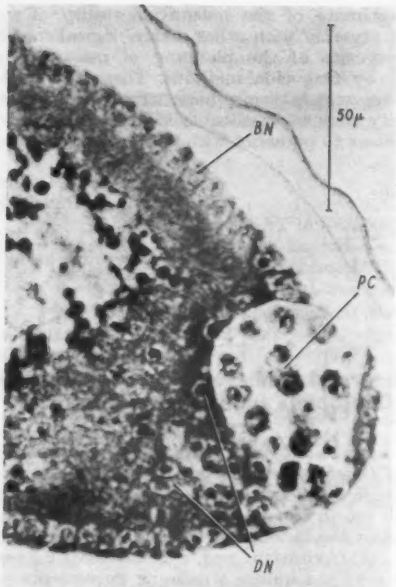


Fig. 1. Posterior region of embryo immediately after treatment at syncytial blastoderm stage. *BN*, blastoderm nuclei; *DN*, displaced blastoderm nuclei; *PC*, pole cell vortex

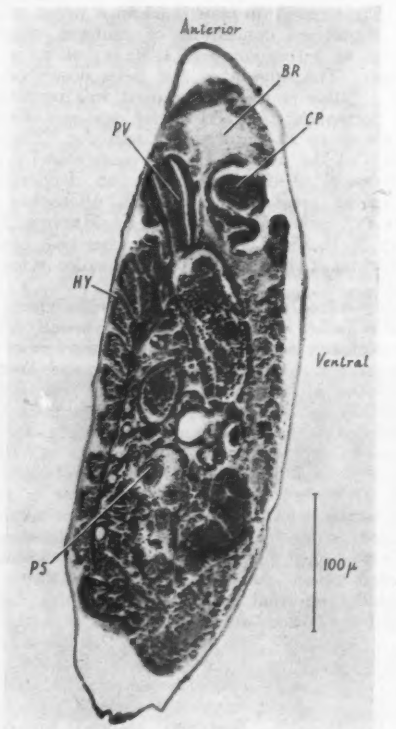


Fig. 2. Longitudinal section of abnormal 20-hr. embryo treated at syncytial blastoderm stage. *BR*, brain (displaced); *CP*, cephalopharyngeal apparatus (displaced); *HY*, hypodermis (note the absence of hypodermis anteriorly and ventrally); *PS*, posterior spiracle (displaced); *PV*, proventriculus (displaced)

and elongation of muscle cells sometimes took place without fusion). Ten showed proliferation of cells without differentiation into cell types, and seven failed to develop. Similar treatments at pre-blastoderm stages were either followed by complete recovery and normal development, or by little or no further development. Our results confirm the observations of delayed mortality made by Fritz-Niggli[3]. For any given dose of ultrasonics, lethality is at a maximum when the treatment is carried out at the syncytial blastoderm stage.

The use of ultrasonics in insect embryology has certain advantages over other experimental methods. No materials are removed from the egg as they are in pricking experiments, and no material need be destroyed by the treatment as it is when ultra-violet radiation or cauterization is applied to selected regions.

This work is in progress and will be reported fully elsewhere. One of us (S. J. C.) was the recipient of the Dorothy Bridgman Atkinson Fellowship, given by the American Association of University Women, and the work received financial support from the Agricultural Research Council. We are indebted to Prof. C. H. Waddington for discussion and encouragement.

G. G. Selman
S. J. Counce

Institute of Animal Genetics,
University of Edinburgh.
June 12.

[1] Selman, G. G., and Wilkins, M. H. F., *J. Sci. Instr.*, **23**, 229 (1949). Selman, G. G., *Exp. Cell Res.*, **3**, 656 (1952).
[2] Harvey, E. N., Harvey, E. B., and Loomis, A. L., *Biol. Bull.*, **55**, 459 (1928).
[3] Fritz-Niggli, H., *Strahlentherapie*, **85**, 233 (1951).

Avian Medullary Bone

Since the report by Kyes and Potter[1] that the marrow cavities of the tibia and femora of female pigeons become filled with endosteal bone during the laying cycle, this phenomenon has been the subject of intensive study in the sparrow[2], duck[3] and domestic fowl[4,5], as well as in the pigeon[6,7]. This highly labile medullary bone appears to serve as a readily available store of calcium for the calcification of the egg shell. It has been studied almost exclusively in the long bones of the legs, though Zondek[8] found it also in the vertebral column of young cockerels after treatment with œstrogen.

In an experiment with eight laying pullets we have found that medullary bone is far less restricted in its occurrence than has been supposed. It is present in all bones, although the skull, humerus, metacarpals, wing digits, metatarsi and toes contain only small amounts. Medullary bone is soft and powdery and may readily be separated from cortical and cancellous bone either by scraping or by careful grinding and sieving. The following table gives the

	Dry fat-free bone weights (gm.)		%
	Total	Medullary	Medullary
Tibia	12·98	1·61	12·4
Femora	10·50	2·29	21·8
Ilia, ischia and pubis	8·86	1·85	20·8
Sternum	6·66	1·03	15·5
Ribs	4·02	1·17	29·2
Ulnæ	4·02	0·16	4·0
Toes	3·63	0·05	1·3
Scapulæ	1·99	0·32	16·1
Total skeleton	95·50	11·21	11·7

amount of medullary bone present in certain bones from a typical pullet fed a standard laying ration and killed immediately after laying her third egg.

T. G. Taylor
J. H. Moore

Department of Agricultural Chemistry,
University, Reading.
June 6.

[1] Kyes, P., and Potter, T. S., *Anat. Rec.*, **60**, 377 (1934).
[2] Pfeiffer, C. A., Kirschbaum, A., and Gardner, W. U., *Yale J. Biol. Med.*, **13**, 279 (*Biol. Abst.*, **15**, 699 (1941)).
[3] Landauer, W., Pfeiffer, C. A., Gardner, W. U., and Shaw, J. C., *Endocrinol.*, **28**, 458 (1941).
[4] Bloom, W., and Domm, L. V., *Anat. Rec.*, **81**, 91 (supplement) (1941).
[5] Common, R. H., Rutledge, W. A., and Hale, R. W., *J. Agric. Sci.*, **38**, 64 (1948).
[6] Bloom, W., Bloom, M. A., and McLean, F. C., *Anat. Rec.*, **81**, 443 (1941).
[7] Bloom, M. A., McLean, F. C., and Bloom, W., *Anat. Rec.*, **83**, 99 (1942).
[8] Zondek, B., *Lancet*, **231**, 842 (1936).

Sex Chromosomes of *Ranatra elongata*

In all the members of the family Nepidæ (Hemiptera–Heteroptera) investigated so far from the above point of view, the diploid number of chromosomes in the male germ-cells has been reported to be 43–38 autosomes and 5 sex chromosomes[1–4]. Chickering's[5] account of the chromosomes of *Ranatra linearis*, according to which the spermatogonia of this insect are of two kinds, one type possessing 40, and the other 48–50 chromosomes, has been shown to be erroneous by Steopoe[2].

Recently, we have been engaged in the investigation of the chromosomes of the male germ-cells of *Ranatra elongata*, collected from the McPherson Lake, Allahabad, and have discovered to our surprise that the sex-determining chromosomes of this species consist of four elements, $X_1X_2X_3Y$, and not of five elements, $X_1X_2X_3X_4Y$, as reported by Steopoe[2] for *R. linearis* and more recently by Dass[4] for *R. elongata* of Bangalore. According to Steopoe, there are, at the first meiotic metaphase, 19 autosomal bivalents and 5 sex chromosomes in *R. linearis*. We find, on the other hand, in Allahabad specimens of *R. elongata*, 19 autosomal bivalents and 4 sex chromosomes ($X_1X_2X_3Y$) at the first meiotic metaphase. The partners of the bivalents separate normally, and all the sex chromosomes divide at this stage (the first metaphase). Each pole thus receives 4 sex chromosomes and 19 autosomes. The interkinesis is completely abolished. At the second metaphase there are 19 autosomes and 4 sex chromosomes, the latter forming a pseudo-quadrivalent and becoming arranged on the equator of the spindle in such a way that the three *X*-chromosomes are placed towards one pole and the *Y* towards the other. The 19 autosomes divide and the 3 *X*-chromosomes and the *Y*-chromosome move to the opposite poles, so that at the end of the second anaphase there are 19 autosomes and 3 *X*-chromosomes at one pole and 19 autosomes and the *Y*-chromosome at the other. The two types of spermatids thus possess 22 and 20 chromosomes respectively and not 23 and 20 elements, as shown by Dass[4] in Bangalore specimens of *R. elongata* and Steopoe[2] in *R. linearis*. Consistently with this, we find 42 chromosomes at the spermatogonial metaphase, and not 43, as reported by Dass[4]. The Allahabad specimens of *R. elongata* differ from the other members of the family Nepidæ by the loss of a single *X*-chromosome.

As reported by Steopoe[2], the *X*-chromosomes are very small and the *Y* is large, all the sex chromosomes occupying a central position in the polar view of the first metaphase, being surrounded by a ring of autosomes. The sex chromosomes are markedly heteropycnotic. In the spermatid nuclei they form a single lump of deeply staining matter, whereas the autosomes are no longer stainable.

M. D. L. Srivastava
C. C. Das

Zoology Department,
University of Allahabad.
May 16.

[1] Steopoe, I., *C.R. Soc. Biol., Paris*, **92**, 1476 (1925).
[2] Steopoe, I., *C.R. Soc. Biol., Paris*, **96**, 1030 (1927).
[3] Steopoe, I., *Ann. Sci. Univ. Jassy*, **16**, 611 (1931).
[4] Dass, C. M. S., *Caryologia*, **4**, 1 (1952).
[5] Chickering, A. M., *Trans. Amer. Micro. Soc.*, **37**, 132 (1918).

Resistance to the Maize Rust, *Puccinia polysora* Underw.

Since 1950, epidemics have been reported of a rust disease of maize due to *Puccinia polysora* Underw. which is new to West Africa[1]. The identity of this rust has been confirmed by Stanton and Cammack[2] by the discovery of the teleutospore phase in Nigeria which agrees with the description by Cummins[3].

Hitherto the most satisfactory method of combating the cereal rusts has been by the introduction of genes for resistance to these diseases. This is so in spite of the ever-changing racial pattern of these rusts. A search was therefore made by us for sources of resistance to *Puccinia polysora*, and a wide range of material, assembled by the Department of Agriculture, Nigeria, has been tested in the field and under controlled conditions using methods similar to those of Manners[4]. The material tested may be classified as follows:

Sources of varieties	Number	Resistance
West Africa	31	No resistance found.
East Africa	7	
South Africa	2	
India	18	No resistance found.
Ceylon	7	
Malaya	2	
United States	20	Of variable resistance.
Mexico	22	Several tolerant and highly resistant varieties.
Caribbean	3	
Venezuela	2	

It is clear that several sources of resistance are available, and, as some of the resistant varieties approach agronomic suitability to West African conditions, little difficulty is likely to occur in their adaptation for West Africa. The location of the source of resistance is interesting in that it provides yet another example to support Vavilov's[5] theory of the centres of origin of cultivated plants, of their associated pathogens which have evolved with them, and of the evolution of genes for pathogen resistance. Preliminary crosses between resistant and susceptible varieties indicate discrete segregation, resistance being dominant to susceptibility, as in the case of resistance to *P. sorghi* Schw.[6]. Several gradations of susceptibility are detectable.

Stage	Degree of susceptibility	Appearance
0	Host immune	No uredosori developed. Hypersensitive flecks present, but no hyphæ in host tissues.
1	Host very resistant	Uredosori abortive and isolated, surrounded by sharply defined necrotic areas.
2	Host moderately resistant	Uredosori small and isolated. Surrounded by necrotic rings within a green island, which may be proximally chlorotic.
3	Host moderately susceptible	Uredosori medium-sized. Chlorotic patches present.
4	Host very susceptible	Uredosori large, numerous, in extensive clusters. Large chlorotic areas.

Of the imported material so far received, five varieties from Mexico show promise of suitability as sources of resistance for the synthesis of varieties adapted to West African conditions.

W. R. Stanton
R. H. Cammack
West African Maize Rust Research Unit,
Moor Plantation,
Ibadan, Nigeria.
June 15.

[1] Rhind, D., Waterston, J. M., and Deighton, F. C., *Nature*, **169**, 631 (1952).
[2] Stanton, W. R., and Cammack, R. H. (in the press).
[3] Cummins, G. B., *Phytopath.*, **31**, 856 (1941).
[4] Manners, J. G., *Ann. App. Biol.*, **37**, 187 (1950).
[5] Vavilov, N. L., "The Origin, Variation, Immunity and Breeding of Cultivated Plants" (1950).
[6] Hayes, H. K., and Immer, F. R., "Methods of Plant Breeding" (New York, 1940).

Effects of Close Spacing on the Growth of Garden Beet

That close spacing restricts the growth of most plants is so obvious as not to require experimental proof. Horticulturally, this is a problem of considerable interest because it means that attempts to increase yields by increasing the plant density are not successful. With some crops 'yield' may bear no close relation to total growth, but this is not so for most root vegetables. Further, with these crops, it is possible to determine for any locality the population-range which can be depended on to give the maximum yield of salable roots. Thus on a fertile loam in Cheshire maximum yields of long beet are assured if the plant population lies between 70,000 and 135,000 per acre. Corresponding figures for globe beet are 110,000 and 150,000 with a possible extension of the latter figure. Within these population-ranges total yields may change slightly; but the yields of salable roots (after rejection of small ones) remain constant. There is almost and sometimes quite complete dependence of root size on available space. Thus in one experiment on globe beet, plants allotted 90 sq. in. each had a mean root weight of 10·88 oz. A reduction in the space available per plant by 60 per cent reduced the mean root weight by 58·4 per cent. Why the closely spaced plants should be so small is not clear. In our experiments, even at the closest spacings employed, adjacent plants do not suffer deformation by mutual pressure. Neither have we evidence that it would be harmful if they did. Clearly, the restriction in size which results from close spacing is not due simply to lack of 'room'. Three factors of the environment, competition for which may occur with closely spaced plants, are light, water and mineral nutrients (including nitrogen).

With garden beet we may assume that the ratio of root weight to top, that is, lamina plus petiole, will give an approximate measure of the photosynthetic efficiency of the leaves. It will be approximate because top weight includes petioles the photosynthetic activity of which is likely to be low in relation to their weight, and the spacing may affect the period of active leaf production. Always we find that when the space available per plant is increased, the weight of tops produced per plant increases (but never so markedly as the increase in available space) and the root/top ratio increases. In single experiments it is not always possible to show that the increase in the root to top ratio is statistically significant; consideration of all the available data, however, leaves one in no doubt as to the reality of the increase. But this effect was appreciable only in 1948 and 1950 and was slight in 1949. In 1949, July and August provided 373 hr. of bright sunshine. Corresponding figures for 1948 and 1950 were 259 and 307 hr. Figures for August only are for the years 1948, 1949 and 1950, 89, 192 and 138 hr. respectively. This does suggest that in relatively sunless years at least, mutual shading of the closely spaced plants may be important, and by restricting photosynthesis, may reduce the flow of assimilates to the storage organ. There is certainly the possibility of this because decreases in available space per plant do not result in proportionate decreases in the weight of tops per plant, so that the weight of tops per unit area of ground is greatest when the plants are closely spaced. Alterations in the root to top ratio induced by spacing changes are, however, never so great as are the changes in the weight of tops per plant. It appears, therefore, that root weight is more dependent on or at least related to leaf weight than to 'leaf efficiency' and that competition for light can play only a small part in restricting the growth of the closely spaced plants.

There is no evidence that competition for water could explain the results obtained. In 1948, July and August provided 7·54 in. of rain (following a rainfall of 4·52 in. in June). In 1950, in only one week subsequent to July 1 was the rainfall less than 0·50 in., and the total for July and August was 6·65 in. Rainfall in 1949 was less abundant at 4·11 in. for July and August; but even so no crops showed any of the signs of distress indicative of a water shortage.

Analyses of leaves from eight of these experiments have failed to reveal any statistically significant effect of close spacing on the contents of nitrogen, potassium, calcium or phosphorus in the leaves when the plants are normally manured. In one experiment, close spacing reduced the nitrogen content of the leaves when the plants received no manure, so that there was a significant positive correlation between nitrogen content of the leaves and root weight, and both were dependent upon the space available per plant. When manured, the nitrogen content of the leaves was not affected by the spacing, but the dependence of root weight on available space persisted. This is the result always obtained on manured plots.

It appears, therefore, that while in the absence of manuring close spacing may result in competition for nitrogen, and that competition for light may be operative, the major effects of close spacing on the growth of normally manured plants cannot be explained solely in terms of competition for water, light or the major nutrient elements.

L. G. G. Warne
Botany Department,
University of Manchester.
May 25.

Influence of Rhizosphere Micro-organisms on the Virulence of *Rhizobium trifolii*

THE increasing interest which has been shown in the interactions of *Rhizobia* with other micro-organisms of the indigenous population of the soil has been reflected in the growing list of organisms which have been found to be inhibitory or antagonistic to their growth in various media. The reviews by Casas-Campillo[1] and Abdel-Ghaffar and Allen[2] emphasize the prominent role of Actinomycetes in such antibioses, but indicate that quite a wide range of bacteria may produce significant effects also. It is noteworthy that, though much attention has been paid to antagonistic organisms, relatively little has been reported of micro-organisms stimulating the activity of *Rhizobia*. Krasilnikov and Korenyako[3] found that a number of non-sporing bacteria of the genera *Pseudomonas* and *Achromobacter* introduced into the rhizosphere of the leguminous host induced an increase in the numbers of *Rhizobia* per gram of rhizosphere soil, and that as a consequence the number of nodules per plant showed an increase and the time taken for nodules to appear was shortened. Such bacteria were termed 'activators' in contrast to types which were inhibitors, or to others which were without effect. These workers advocate that seed should be inoculated with mixed cultures of *Rhizobia* plus activators on the basis of their findings of increased herbage yield and seed set of beans, lucerne and lupins.

While investigating the plant–rhizobial relationships between *Trifolium subterraneum* (subterranean clover) and strains of *Rhizobium trifolii* in pot experiments, it was noticed that one strain (No. 44) gave an ineffective reaction as measured by plant growth in sterilized soils; but in similar soils not subject to heat treatment, an effective reaction was obtained with no evidence of nitrogen starvation symptoms.

Examination of the root systems showed that in sterilized soils nodulation was scanty and restricted to a few small, round clumps of confluent, clavate nodules. In the non-sterile soils, nodulation was unrestricted and much more profuse in quantity, but of the same characteristic morphology. Occasional nodules produced from infection by the indigenous *Rhizobia* of these soils were large and flabellate, and readily distinguished from those produced by the inoculated organism. It was further noticed that root growth in non-sterile soils showed varying degrees of discoloration and sloughing of fragments. Plating out surface sterilized (alcohol-peroxide) pieces of roots on suitable nutrient agars revealed infection by a range of fungi and bacteria frequently found in association with plant roots. The fungi most frequently encountered were members of the genera *Fusarium*, *Trichoderma*, *Penicillium*, *Aspergillus* and various dark-coloured Dematiaceæ. The range of bacteria found was diverse and included both sporing and non-sporing types typical of zymogenous activity in the proximity of plant roots.

Surface-sterilized seeds of subterranean clover were germinated on water-agar, the testa removed, embryos re-sterilized and transferred for aseptic growth on slopes of a mineral salts–soft agar medium free from sources of nitrogen and carbohydrate, but which was capable of adequately providing other major and trace nutrient elements. The test-tubes containing the plants were held in the glass-house until the first trifoliate leaf had unfolded, and then inoculated with a suspension of organisms grown on agar slopes. The accompanying table shows the comparison in nodule numbers for two strains, Nos. 44 and 430, of *Rh. trifolii* with a nil control series from which the *Rhizobia* have been withheld. Strain 430 is an effective strain with nodulation little affected by the presence of the other rhizosphere fungi and bacteria applied with the inoculum. Strain 44 is poorly virulent, and forms few nodules on subterranean clover in pure culture. In the presence of some fungi and bacteria its ability to produce successful infection of the root system is enhanced, and nodulation improves to give an effective reaction.

NODULE COUNTS PER PLANT FOR SUBTERRANEAN CLOVER GROWN IN TEST-TUBES AND SIMULTANEOUSLY INOCULATED WITH STRAINS OF *Rh. trifolii* AND OTHER RHIZOSPHERE FUNGI AND BACTERIA. MEANS OF THREE REPLICATE TUBES EACH WITH TWO PLANTS PER TUBE. STANDARD ERROR OF TREATMENT MEAN ± 2·4

	Nil control	*Rh. trifolii* strain 44	*Rh. trifolii* strain 430
Nil control	0	2·3	12
Fungus			
1013 (*Fusarium*)	0	1·7	0
1015 (*Sclerotinia*)	0	0	1
1017 (Dematiaceæ)	0	7·7	6
1018 (Dematiaceæ)	0	8·7	13
1019 (*Trichoderma*)	0	3·0	12
M (*Hormodendrum*)	0	0	12
N (*Hormodendrum*)	0	0	6
O (*Fusarium*)	0	0	14
Bacteria			
1506	0	0	13
1507	0	0	13
1508	0	12	14
1509	0	14	15
1510	0	13	11
1511	0	12	9
1512	0	14	13

The presence of a parasitic organism capable of rapidly killing the plant completely inhibits nodule formation as in the case of *Fusarium* 1013 and *Sclerotinia* 1015; where the degree of parasitism is not so great, but invasion of root tissues takes place with extensive local root rots, as in the case of the dematiaceous fungus 1017 and *Hormodendrum N*, the nodulation with *Rh. trifolii* strain 430 shows a reduction probably due to impaired functions of the metabolism of the plant rather than direct antagonism of the fungus to the *Rhizobia*. Some strains of fungi and bacteria were capable of stimulating the poorly virulent strain 44, but others produced no effect. Where stimulation is sufficient to produce an adequate volume of nodular tissue, the plant reaction is effective. Strain 44 may thus be regarded as a strain efficient in nitrogen fixation but of poor virulence. Its apparent ineffective reaction in sterilized soils is not necessarily reproduced in natural soils under non-sterile conditions where the presence of a wide range of soil organisms may be capable of this non-specific stimulation of virulence in the rhizosphere. The question arises as to whether such poorly virulent strains of *Rhizobia* may be safely used in the artificial inoculation of legume seeds on a commercial basis, assuming that stimulation will be adequate in the rhizosphere, or whether in testing strains of *Rhizobia* for such purposes, care should be taken to select only highly virulent types which are efficient in nitrogen fixation, or whether to add the so-called 'activators' as suggested by Krasilnikov and Korenyako[3]. Furthermore, one wonders whether many of the cases of reports of large numbers of strains of *Rhizobia* of inefficient nitrogen fixation found in soils under natural conditions may not have been made on the basis of poorly virulent strains giving apparently ineffective plant reactions when tested under sterile conditions. Despite such claims, there appear

in the literature very few cases of failure of legumes which can be definitely ascribed to a predominant nodulation by ineffective strains of indigenous *Rhizobia*.

These observations form part of a series of investigations being undertaken on the ecological relationships of *Rh. trifolii* and its importance as a factor in the establishment of subterranean clover in soils of low fertility, the results of which will be reported in greater detail elsewhere.

J. R. Harris

Soil Microbiology Section, Division of Soils,
Commonwealth Scientific and
Industrial Research Organization,
Waite Agricultural Research Institute,
Adelaide, South Australia.

[1] Casas-Campillo, C., *Ciencia*, **9**, 193 (1949).
[2] Abdel-Ghaffar, A. S., and Allen, O. N., Trans. Fourth Int. Cong. Soil Sci., **3**, 93 (1950).
[3] Krasilnikov, N. A., and Kerenyako, A. I., *Mikrobiologiia*, **13** (1) 39, (1949).

Structure of Poly-D-glutamic Acid isolated from Capsulated Strains of *B. anthracis*

We have already shown[1,2] that the poly-D-glutamic acid of molecular weight 6,400–9,000 which *B. subtilis* secretes into the culture medium contains γ-glutamyl links (I, R = COOH) in such predominance that few α-glutamyl links (III, R = COOH) can be present in the substance. This statement is based on the observation that in the acid hydrolysate of the polyamine derivative (I, $R = NH_2$) prepared from the polypeptide, by Curtius degradation of the polyhydrazide (I, $R = CON_2H_3$) or by Hofmann degradation of the polyamide (I, $R = CONH_2$), only β-formylpropionic acid (II) appears in quantities easily assayable by preparative methods, and no α.γ-diaminobutyric acid was found to be present. Control experiments with synthetic α-polyglutamic acid, on the other hand, readily gave α.γ-diaminobutyric acid (IV) on acid hydrolysis of the degradation product.

Hanby and Rydon[3] came to the reverse conclusion regarding the predominating type of the glutamyl linkages with poly-D-glutamic acid separated from capsulated strains of *B. anthracis*. Since Ivánovics and Bruckner[4] found no difference by chemical and serological reactions between the polyglutamic acids of identical molecular weight (6,400–7,100) isolated from the two species of bacilli, extension of the above degradation to poly-D-glutamic acid of *B. anthracis* appeared desirable.

For the preparation of the polypeptide, a non-sporing capsulated *B. anthracis* strain (No. *A* 71 *T*) of low virulence was used, which appears to be identical as regards its morphological and cultivation characteristics with the cultures furnished by White[5] for Hanby and Rydon's experiments. This strain was raised from a capsulated strain (No. *A* 71) of high virulence which was inoculated into horse serum, then kept for three weeks at 37° and used afterwards for isolation of the strain in question. Isolation of the crude polypeptide from agar cultures of this strain followed strictly Hanby and Rydon's method[3]. This substance was dried *in vacuo* at room temperature, then esterified with methyl alcohol by addition of acetyl chloride. The crude ester was now repeatedly fractionated from methanol by precipitation with increasing quantities of ether. After stepwise extraction with cold water there remained an undissolved fraction which contained no ash and had the average molecular weight of 45,000–53,000 (van Slyke), which is in the order shown by specimens described by Hanby and Rydon. Analysis demonstrated about 75 per cent esterification of the carboxyl groups. The slight solubility in water appears to be due to the presence of the remaining free carboxyl groups. In degradation, both of the polyhydrazide and polyamide prepared from the polyester, only β-formylpropionic acid (II) could be detected by preparative methods but no α.γ-diaminobutyric acid (IV). This suggests that also in the high molecular-weight poly-D-glutamic acid of *B. anthracis* it is the γ-glutamyl link which is the predominant type.

Details of this work will be published elsewhere.

V. Bruckner
J. Kovács

Institute of Organic Chemistry,
University of Budapest.

G. Dénes

Institute of Medical Chemistry,
University of Budapest. April 6.

[1] Kovács, J., and Bruckner, V., *Research*, **5**, 194 (1952); *J. Chem. Soc.*, 4255 (1952). Bruckner, V., Kovács, J., and Nagy, H., *J. Chem. Soc.*, 148 (1953).
[2] Kovács, J., Bruckner, V., and Kovács, K., *J. Chem. Soc.*, 145 (1953). Bruckner, V., Kovács, J., and Kovács, K., *J. Chem. Soc.* (in the press).
[3] Hanby, W. E., and Rydon, H. N., *Biochem. J.*, **40**, 297 (1946).
[4] Ivánovics, G., and Bruckner, V., *Naturwiss.*, **25**, 250 (1937); *Z. Immunforsch.*, **90**, 304; **91**, 175 (1937).
[5] White, B., *Biochem. J.*, **40**, 308 (1946).

Intracellular Distribution of Rhodanese in Cardiac Muscle

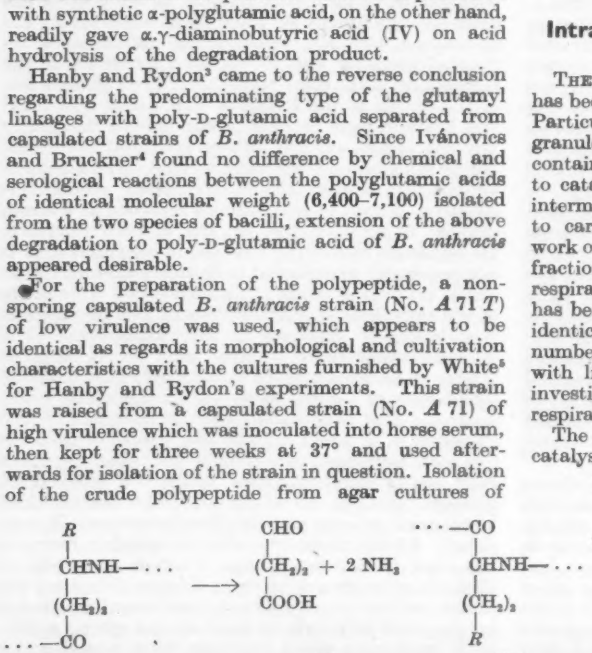
The distribution of enzymes within animal tissues has been studied most extensively in the case of liver. Particular interest has centred round the large granules (mitochondria), which have been found to contain the components of the cytochrome system, to catalyse the oxidation of all the citric acid cycle intermediates and the oxidation of fatty acids, and to carry out oxidative phosphorylation[1]. Recent work on cardiac muscle has shown that the particulate fraction (sarcosomes[2]) has a similar complement of respiratory enzymes and co-enzymes[2,3]; and there has been a tendency for sarcosomes to be considered identical with mitochondria. However, a large number of other enzymes are known to be associated with liver mitochondria, and it was of interest to investigate the distribution of one of these non-respiratory enzymes in cardiac muscle.

The enzyme chosen for study was rhodanese, which catalyses the reaction,

$$HCN + Na_2S_2O_3 \rightarrow HCNS + Na_2SO_3.$$

Most of the rhodanese activity of liver has been found in the mitochondria[4].

Calf cardiac muscle was homogenized in 0·88 *M* sucrose[5] and three fractions were obtained by differential centrifugation: (*a*) myofibrillar-



INTRACELLULAR DISTRIBUTION OF RHODANESE

	Liver (Ludewig and Chanutin)	Cardiac muscle (Moyle)		
Fraction	Total activity (per cent)	Total activity (per cent)	Total dry wt. (per cent)	Specific activity
Homogenate	100	100	100	1
(*a*) Residue	15	44		
(*b*) Large particles	62	2	9·3	0·2
(*c*) Supernatant	7	56		
a + *b* + *c*	84	102		

nuclear residue, (*b*) sarcosomes and (*c*) sarcoplasm. Rhodanese activity was estimated by the method of Cosby and Sumner[6]. A comparison of the activity of the homogenate and the tissue fractions showed that the sarcosomes contained no rhodanese, the total activity of the muscle being only about 10 per cent that of liver (per unit weight).

Cleland and Slater[2] have reported a parallel situation in the distribution of myokinase, which occurs in the sarcoplasm of cardiac muscle but in the mitochondria of liver[7].

So, although the 'large granules' from liver and heart muscle show similarity in being the site of respiratory enzyme systems, they are not completely identical units differing only slightly in morphology from tissue to tissue. In their diverse non-respiratory functions they may take very different roles in the metabolism of their respective tissues.

I wish to thank Dr. M. Dixon for valuable advice, and the Medical Research Council for a grant.

JENNIFER M. MOYLE

Department of Biochemistry,
University of Cambridge. April 22.

[1] Green, D. E., "Enzymes and Enzyme Systems" (Harvard, 1951). Hogeboom, G. H., *Fed. Proc.*, **10**, 640 (1951). Lehninger, A. L., "Enzymes and Enzyme Systems" (Harvard, 1951).
[2] Cleland, K. W., and Slater, E. C., *Biochem. J.*, **53**, 547 (1953).
[3] Paul, M. H., Fuld, M., and Sperling, E., *Proc. Soc. Exp. Biol. Med.*, **79**, 349 (1952).
[4] Ludewig, S., and Chanutin, A., *Arch. Biochem.*, **29**, 441 (1950).
[5] Hogeboom, G. H., Schneider, W. C., and Pallade, G. E., *J. Biol. Chem.*, **172**, 619 (1948).
[6] Cosby, E. L., and Sumner, J. B., *Arch. Biochem.*, **7**, 457 (1945).
[7] Kielley, W. W., and Kielley, R. K., *J. Biol. Chem.*, **191**, 485 (1951).

Activation of Fumaric Hydrogenase by Ferrous Ions

FISCHER *et al.*[1] described an enzyme from yeast which catalyses the reduction of fumarate to succinate by leuco-dyestuffs. They showed that the coenzyme is flavine adenine dinucleotide.

It has now been found that addition of flavine adenine dinucleotide does not fully restore the activity of this enzyme after dialysis and adsorption on alumina C_γ, but that addition of ferrous ions is also necessary.

Thunberg tubes contained: 0·5 ml. 0·05 *M* phosphate buffer *p*H 7·4 and 1 ml. 0·03 *M* fumarate. In stopper: 0·5 ml. 0·0002 *M* janus green reduced with 0·2 mgm. hydrosulphite. Gas, nitrogen.

ACTIVATION OF FUMARIC HYDROGENASE

Additions	Oxidation time (min.)
Nil	> 25
Fe^{++}	> 25
Enzyme	10½
Enzyme + Fe^{++}	1½

Additions: 1 ml. enzyme (dialysed in the presence of flavine adenine dinucleotide); 0·2 ml. 0·01 *M* $FeSO_4$. Other metals such as Mn^{++} are ineffective. Keilin–Hartree preparations of succinic dehydrogenase from heart muscle also lose activity on dialysis; addition of ferrous ions enables the reduction of fumarate to take place. It would appear, therefore, that ferrous ions are required for electron transfer in succinate–fumarate systems.

K. HARRISON

Department of Biochemistry,
Cambridge. May 4.

[1] Fischer, F. G., *et al.*, *Ann. Chem.*, **552**, 203 (1942).

Chromaffin Bodies of Various Species of Dogfish

IN lower vertebrates, structures homologous to the adrenal gland of higher vertebrates remain separated throughout life. In the dogfish, for example, an unpaired inter-renal body representing the adrenal cortex is quite separate from the chromaffin bodies or rudimentary adrenal medulla. Extracts of each component can therefore be made without contamination by the other part.

Since workers in both our departments are interested in the biosynthesis of adrenaline, we have investigated by chromatographic and biological methods the amines present in the chromaffin bodies of *Scylliorhinus canicula* and *stellaris* (in Bari), *Squalus acanthias* and *Mustelis canis* (in Dundee) and *Torpedo marmorata* (in both Bari and Dundee). Our pooled results are shown in the accompanying table. Large quantities of adrenaline and noradrenaline are contained in these extracts; but hydroxytyramine, dihydroxyphenylalanine, dihydroxyphenylserine, tyramine and octopamine (*p*-norsynephrine) are not present in detectable amounts. Concentrated extracts of the livers, kidneys, intestinal tract, and inter-renal bodies of these dogfish species do not contain significant amounts of any of the seven substances mentioned.

AMINES (μGM./GM.) PRESENT IN THE CHROMAFFIN BODIES OF DOGFISH SPECIES

Species	Adrenaline	Noradrenaline	Noradrenaline (per cent in total)
Squalus acanthias	900	2,400	73
Mustelis canis	1,000	2,200	69
Scylliorhinus canicula	1,150	2,200	66
Scylliorhinus stellaris	850	1,900	67
Torpedo marmorata	150	600	80

These results do not assist in advancing the method by which adrenaline and noradrenaline are formed in the body. However, it is evident that even the pathways through dihydroxyphenylalanine and hydroxytyramine, or through tyramine and *p*-norsynephrine, must be considered doubtful.

D. M. SHEPHERD
G. B. WEST

Department of Pharmacology and Therapeutics,
University of St. Andrews Medical School,
Dundee.

V. ERSPAMER

Department of Pharmacology,
University of Bari,
Italy. April 29.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 14

ROYAL AERONAUTICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Prof. N. J. Hoff (New York): "Structures" (Forty-first Wilbur Wright Memorial Lecture).

Monday, September 14—Friday, September 18

INSTITUTION OF NAVAL ARCHITECTS (at the Kurhaus, Scheveningen, Holland)—Autumn Meeting.

Tuesday, September 15—Thursday, September 17

ROYAL AERONAUTICAL SOCIETY (at Friends House, Euston Road, London, W.C.1).—Fourth Anglo-American Aeronautical Conference.

SEVENTH WORLD COCOA CONFERENCE (at Grosvenor House, Park Lane, London, W.1).

Wednesday, September 16

PHYSICAL SOCIETY, COLOUR GROUP (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Mr. Ralph M. Evans (U.S.A.): "Some Aspects of White, Grey and Black".

Thursday, September 17—Saturday, September 19

ROYAL GEOGRAPHICAL SOCIETY (joint meeting with the INSTITUTE OF BIOLOGY, at 1 Kensington Gore, London, S.W.7), at 10 a.m. each day.—Symposium on "The Biology and Productivity of the Sea".

SOCIETY FOR WATER TREATMENT and EXAMINATION (at Manchester).—Autumn Meeting.

Friday, September 18

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The School of Medicine, Leeds), at 11 a.m.—Scientific Papers.

Friday, September 18—Sunday, September 27

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION (in the Recital Room, Royal Festival Hall, and the National Film Theatre, London, S.E.1).—Seventh Annual Congress.

Saturday, September 19

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1), 2–5.30 p.m.—Exhibition*.

Saturday, September 19—Friday, September 25

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, London, S.W.7).—Centenary International Conference on "The Science and Applications of Photography".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PROFESSOR OF SOCIAL SCIENCE at the Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 17).

HEAD (honours graduate in chemistry, physics or metallurgy, with teaching, industrial and/or research experience and with corporate membership of a professional institution and preferably with experience of administration in a senior technical college) OF THE DEPARTMENT OF PURE AND APPLIED SCIENCE, Enfield Technical College—The Chief Education Officer (F/CW/2), 10 Great George Street, Westminster, London, S.W.1 (September 19).

PLANT PHYSIOLOGIST (with good honours degree in botany or agricultural botany) at the Unit of Plant Nutrition, Long Ashton, Bristol, to work on the effects of mineral nutrients on the metabolism of crop plants grown in controlled environments—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 21).

SENIOR LECTURER or LECTURER IN PHYSICS and a SENIOR LECTURER or LECTURER IN BOTANY at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 21).

ENGINEERING ASSISTANT, Senior Scientific Officer grade (corporate member of the I.C.E., I.Mech.E. or I.E.E., preferably with university degree, and with at least three years experience in engineering research or development, education or administration), IN THE SCIENCE Department—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Engineering" (September 25).

PHYSICIST (with first- or second-class honours degree) as Hospital Physicist—The Secretary, Liverpool Radium Institute Management Committee, 1 Myrtle Street, Liverpool 7 (September 26).

PRINCIPAL (with honours degree in engineering or equivalent qualification) for the Kingston Technical School, Jamaica—Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.114/32/01 (September 26).

SCIENTISTS (with first- or second-class honours degree in physics, engineering or mathematics or equivalent qualification, and several years research experience) IN THE FIELD INVESTIGATIONS GROUP—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/683 (September 26).

ASSISTANT KEEPER IN ZOOLOGY (with good honours degree in zoology or equivalent qualification) in the Manchester Museum—The Registrar, The University, Manchester 13 (October 3).

ENGINEERS (3) (with first- or second-class honours degree in civil or mechanical engineering) in the Department of Scientific and Industrial Research, Forest Products Research Laboratory, Princes Risborough, for investigations on timber strength, wood sawing and machining—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.99/53A (October 3).

SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry or equivalent qualification, and preferably with knowledge of physical methods applicable to inorganic analysis) to take part in a special investigation needing a sound knowledge of mineral chemistry and general experience of mineral analysis (Ref. No. F.434/53 A); SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry or equivalent qualification, and with sound knowledge of mineral chemistry and experience of mineral analysis) to undertake analysis and examination of minerals and their products, rocks and fuels, and to assist in development of suitable methods (Ref. No. F.435/53A); ASSISTANT EXPERIMENTAL OFFICER (with G.C.E. with scientific subjects at advanced level, and preferably with experience of applied inorganic analysis) for duties in connexion with mineral analysis and investigations (Ref. 436/53A), at the Directorate of Colonial Geological Surveys—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (October 3).

PRINCIPAL FOR THE COLLEGE OF TECHNOLOGY, Bristol—Chief Education Officer, Council House, College Green, Bristol 1 (October 14).

LECTURER IN BIOCHEMISTRY (preferably with interests in the field of protein chemistry)—The Registrar, The University of Adelaide, Adelaide, South Australia (October 31).

ASSISTANT EXPERIMENTAL OFFICER (with H.S.C. science or equivalent qualification, and with experience in research and development work in spectro-chemical analysis) at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.438/53A.

ASSISTANT LECTURER, Grade B (with honours degree in chemistry) IN CHEMISTRY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

ASSISTANT SUPERINTENDENT, Senior Scientific Officer grade (with thorough knowledge of the use and testing of textile and related material used on railways), IN THE TEXTILES DIVISION, Research Department, Derby—The Director of Research, The Railway Executive, 222 Marylebone Road, London, N.W.1.

CHEMIST (with good honours degree in chemistry and with ability to study agronomic problems and knowledge of soil chemistry and physics, and the layout and analysis of modern fertilizer trials) at the Sugarcane Research Station, Mauritius—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27106/37.

JUNIOR FELLOW (engineering graduate, and with an interest in experimental aerodynamics) IN AERONAUTICAL ENGINEERING, for work mainly on the design of low speed and supersonic wind tunnels—The Registrar, The University, Bristol 8.

LECTURER (with experience and special interest in micro and semi-micro analysis, and with industrial or research experience) IN INORGANIC CHEMISTRY, and an ASSISTANT, Grade B (with good honours degree in chemistry) IN ORGANIC CHEMISTRY—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

PHYSICIST (with first- or second-class honours degree in science and preferably with five years experience as a hospital physicist) in the Medical Department, Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.117/51/013.

SCIENTIFIC OFFICER, Grade 2 (with good honours degree in physics or engineering) AT THE MECHANICAL ENGINEERING RESEARCH ORGANIZATION, East Kilbride, to work on problems of friction and adhesion—Director of Research, The Railway Executive, 222 Marylebone Road, London, N.W.1.

SENIOR HYDROLOGIST (with honours degree in an applied science, preferably civil engineering, and with experience in all aspects of river gauging, rainfall, run-off studies, evaporation, study of ground water, and the determination of the water resources of catchment areas) in the Hydrology Section, Public Works Department, Kenya—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/7/012.

SENIOR LECTURER (with good honours degree and with industrial and research experience) IN THE HEAT ENGINES SECTION of the Department of Civil and Mechanical Engineering—The Secretary, The Royal Technical College, Glasgow.

SENIOR LECTURER (with degree in agricultural, veterinary or pure science) in physiology of the sheep IN THE DEPARTMENT OF SHEEP HUSBANDRY AND WOOL, Massey Agricultural College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry or metallurgy, and with at least three years post-graduate research experience in electrodeposition or allied fields) to take charge of all research on electrodeposition of metals, including improvements of chromium deposits, devising methods for alloy deposits, and physical examination of deposits (Ref. F.432/53A); EXPERIMENTAL OFFICERS (*a*) Chemist (with H.S.C. science or equivalent qualification) for research on electrodeposition of improved metals and alloys, adhesion of electrodeposits to 'difficult' substrates, electrochemical and chemical polishing, and (*b*) METALLURGIST (with H.S.C. science or equivalent qualification) to participate in gunfiring trials and to undertake detailed inspection, including metallographic examination of fired barrels (Ref. F.433/53A), at a Ministry of Supply Research Establishment in South-East London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.